AT&T 254-302-221
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MAGNETIC TAPE SYSTEM KS-23113

GENERAL DESCRIPTION

AT&T 3B20D MODEL 2 AND MODEL 3 COMPUTER

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1. GENERAL

1.01 This section provides physical and functional descriptions of the KS-23113, L12 STU (streaming tape unit) used with the 3B20D computer.

1.02 Whenever this section is reissued, the reason(s) for reissue will be listed in this paragraph.

1.03 The 3B20D computer uses the magnetic tape to:

- Store general data
- Handle call billing data
- Provide physical disk to tape backup

- Provide system update from the LDFT (load disk from tape) format

- ***Dead start*** the system from tapes that contain the backup system image from the LDFT format

- Write ***offline*** disk partion from the LDFT format.

1.04 The KS-23113, L12 is a KS-23113, L1 recorder equipped with the KS-23113, L4 buffered standard interface board with all the necessary retrofit hardware, firmware, and instructions to upgrade L1 to L12.

1.05 The KS-23113, L12 STU writes and reads nine tracks of data on a half-inch wide magnetic tape using a phase-encoded format. The STU consists of a tape deck, R/W (read/write) electronics, formatting electronics, microprocessor based control logic and adapter interfaces. The STU has three operating modes: 25 IPS (inches per second) start/stop mode, 25 IPS streaming mode, and 75 IPS streaming mode. Data is recorded in the ANSI (American National Standard Institute) compatible 1600 BPI PE (phase encoded) or 6250 BPI GCR (group coded recording) method.

1.06 Tapes written or read are interchangeable with any other ANSI compatible tape unit. A tape written GCR in either 25 IPS start/stop or streaming mode or 75 IPS streaming mode is interchangeable with any other ANSI compatible GCR recording start/stop or STU.

1.07 In the buffered mode, data transfer rates can be optionally selected up to a maximum of 750,000 bytes per second.

1.08 In the nonbuffered mode, multiple data transfer rate capability is achieved by allowing selection of the 25 IPS and 75 IPS streaming mode and density selection through the adapter interface. The 25 IPS modes operate at an instantaneous data rate of 40,000 bytes per second when in the PE mode and 156,250 bytes per second when in the GCR mode. The 75 IPS streaming mode operates at 120,000 bytes per second when in the PE mode and 468,750 bytes per second when in the GCR mode.

1.09 Selection of either a normal IBG (interblock gap) length of 0.6 inch or a longer IBG length of 1.2 inches when in PE (phase encoded) mode and 0.3 inch when in the GCR mode is also available through the adapter interface. Additional, long and short gaps can be selected to be variable length. The standard configuration of the tape unit is defined with these gaps to be variable in length from the minimum lengths to the maximum lengths as described.

1.10 The STU/adapter interface is based on the industry standard interface formatted OEM 1/2 inch tape units. Certain additonal functions such as special mode change and long gap have been included in the interface while maintaining interface conventions for basic timing, command protocol, and data transfer. The STU also supports transparent extensions to the industry standard interface in that sense, density select, remote diagnostic exectuion, and diagnostic loopback are provided. This design approach allows for ease of integration of the STU with existing adapter designs. The maximum cable length is 20 feet total from the adapter to the STU. The interface is electrically and functionally compatible with Control Data Corporation Models 92180, 92181, and 92185 streaming tape units except for data transfer rates and added provisions for density select and remote diagnostic initiation capabilities.

TAPE PERIPHERAL CONTROLLER

1.11 The 3B20D computer 9-track tape peripheral controller (UN145 circuit pack) is located in the IOP (input/output processor). The tape peripheral controller interfaces with the PIC (peripheral interface controller) over the IOMI bus in the IOP. The tape controller accepts commands from the IOP and interprets these commands to control, write, and read 9-track magnetic tape at moderately high speed. The tape controller communicates with the STU over a 50-pair TTL (transistor-transistor logic) bus within a maximum distance of 20 feet.

1.12 The tape controller accommodates tape drives with instanteous read/write data rates up to 1.1 megabytes per second. The maximum block size is 6144 bytes. Block operation can overlap; that is, once a block read or write is initiated, the PIC does not have to wait for a completion from the formatter before setting up another order to the same transport. The tape controller can address up to four different transports.

1.13 The UN145 is a microprocessor system on one circuit board, based on the Intel 8085A microprocessor chip. The 8085A is driven from a 5 MHz external clock which generates an internal clock cycle of 400 nanoseconds. The memory system consists of 4K PROM (in which resides the bootstrap, a part of the diagnostic and executive firmware). The operational and diagnostic programs are pumped into 8K of static RAM (random access memory). The handshaking between the UN145 and the PIC occurs via 2K static RAM, referred to as the LDPM (lower dual port memory). Two 6K static RAMs handle data block transfers between the UN145 and the PIC and are referred to as the UDPM (upper dual port memory).

1.14 Other major devices attached to the 8085A bus system are 48 I/O (input/output) ports (2-8255 devices), a DMA (direct memory access) chip to transfer data between memory and tape, and a programmable internal timer, to generate required timing functions.

1.15 The STU operates within 104 to 128 VAC, nominal 120 VAC, single-phase, 60-Hz power supply. A 2-wire plus ground, shielded power cord is provided. The average input current of the STU is 3.2 amperes.

1.16 Earth ground is obtained via the power cord. An EMC ground is provided by system grounding the shielded jackets of the I/O cables. Logic ground referencing is provided via the interface connectors. A single point grounding scheme is used to connect logic ground to frame/earth ground.

CONFIGURATION

1.17 The 3B20D computer can support up to four tape units. The quantity of tape units is dependent upon the application of the system. If the system contains two or more tape units, the units are connected in a daisy-chain method (Fig. 1). The maximum distance between the adapter interface and the last tape unit is 20 feet.

2. PHYSICAL DESCRIPTION

2.01 The tape unit is located on the tape transport frame (Fig. 2). The frame is standard and is 7 feet high, 2 feet 2 inches wide, and 24 inches deep. The tape unit frame can contain up to two tape units. The tape unit is designed to be mounted in a standard rack that is 24 inches high, 19 inches wide, and 17.5 inches deep. The normal color of the door is light grey with blue door trim strip. The weight of the unit is less than 110 pounds. The tape unit has a plastic-hinged front cover to protect the tape transport from dust and other foreign matter (Fig. 3). A transparent window in the front cover allows tape motion to be seen. The cutout in the front cover allows access to the control panel (Fig. 4). The components on the front of the tape deck are shown in Fig. 5. The components on the rear of the tape deck are shown in Fig. 6.

OPERATOR CONTROL PANEL

2.02 The operator control panel includes switches, indicators, and a display. The control panel is accessible from the front of the tape unit (see Fig. 4).

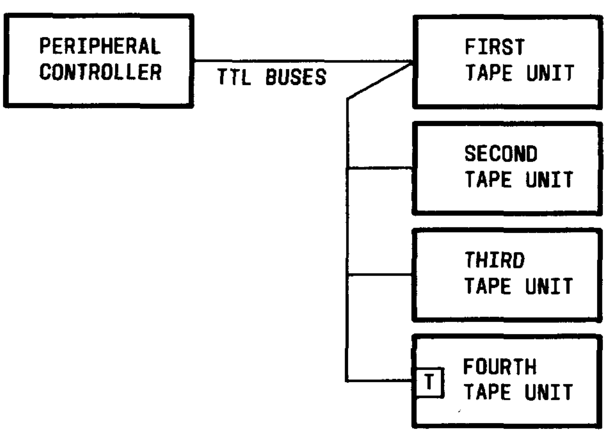


Fig. 1—Maximum System Configuration

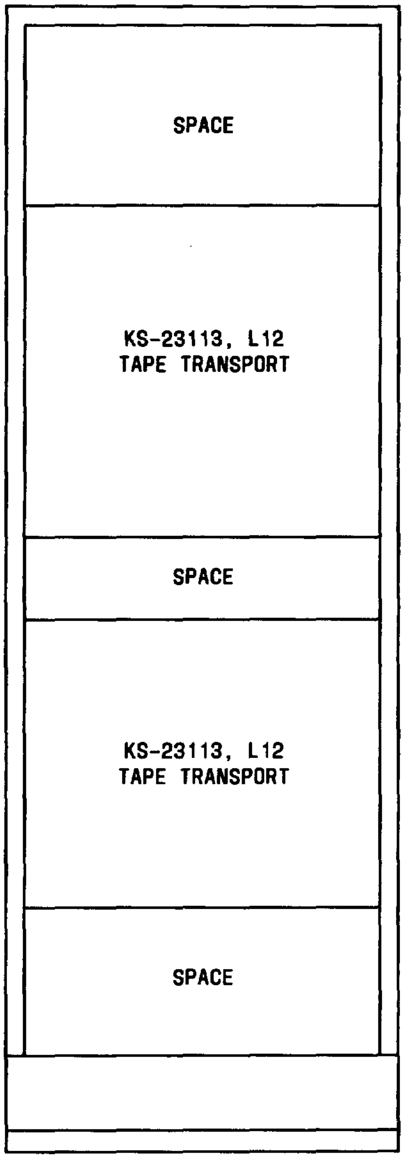


Fig. 2—Tape Transport Frame

SUPPLY AND TAKEUP REELS

2.03 The supply hub is a manual mechanical latching device that secures the tape reel to the unit. The supply reel is latched by pressing the peripheral of the hub face while the reel is positioned against the rear flange of the hub. The supply reel is released by pressing the center button of the hub face.

2.04 The take-up reel is a permanently mounted reel secured to the take-up motor shaft. The take-up reel motor has a 1000-segment tachometer attached which provides velocity control.

FILE PROTECTOR ASSEMBLY

2.05 The file protector assembly consists of a 360-degree reflecting ring around the file (supply) hub and a phototransistor sensor mounted adjacent to the reflecting ring. If a write enable ring is installed, the reflecting ring is in direct line with the sensor. If the enable ring is absent, the reflecting ring is out of the path of the sensor.

UPPER AND LOWER AIR BEARINGS

2.06 The upper and lower air bearings provide an air cushion allowing tape tension control over the record and playback surface of the magnetic head. Solid-state air pressure sensors integrated in the air bearings provide information to the supply reel motor to maintain the required tension; in addition, both upper and lower air bearing assemblies provide guidance of the tape across the magnetic heads.

BOT/EOT/AOT BLOCK

2.07 The BOT (beginning-of-tape) and EOT (end-of-tape) markers are detected by an optical device consisting of a light source and phototransistors. The phototransistors detect reflected light from the BOT and EOT markers on the tape. The AOT (absence-of-tape) condition is detected when both BOT and EOT phototransistors detect a presence of light reflected from a unit mounted reflector which is normally covered by the tape.

MAGNETIC HEAD ASSEMBLY

2.08 The magnetic head is a dual gap head designed to perform the read/write function in a 9-track, PE (phase encoded) mode and GCR mode. A full-width erase head is provided to erase tape in the forward direction before passing the tape over the write head. Selection of the read or write operation is made by the IOP through the control logic circuits. Data is transferred to or from the IOP or TTL (transistor-transistor logic) buses and gated to the individual head by the read/write circuit. The read recovery circuit converts the read data to a digital format compatible with the control and formatter

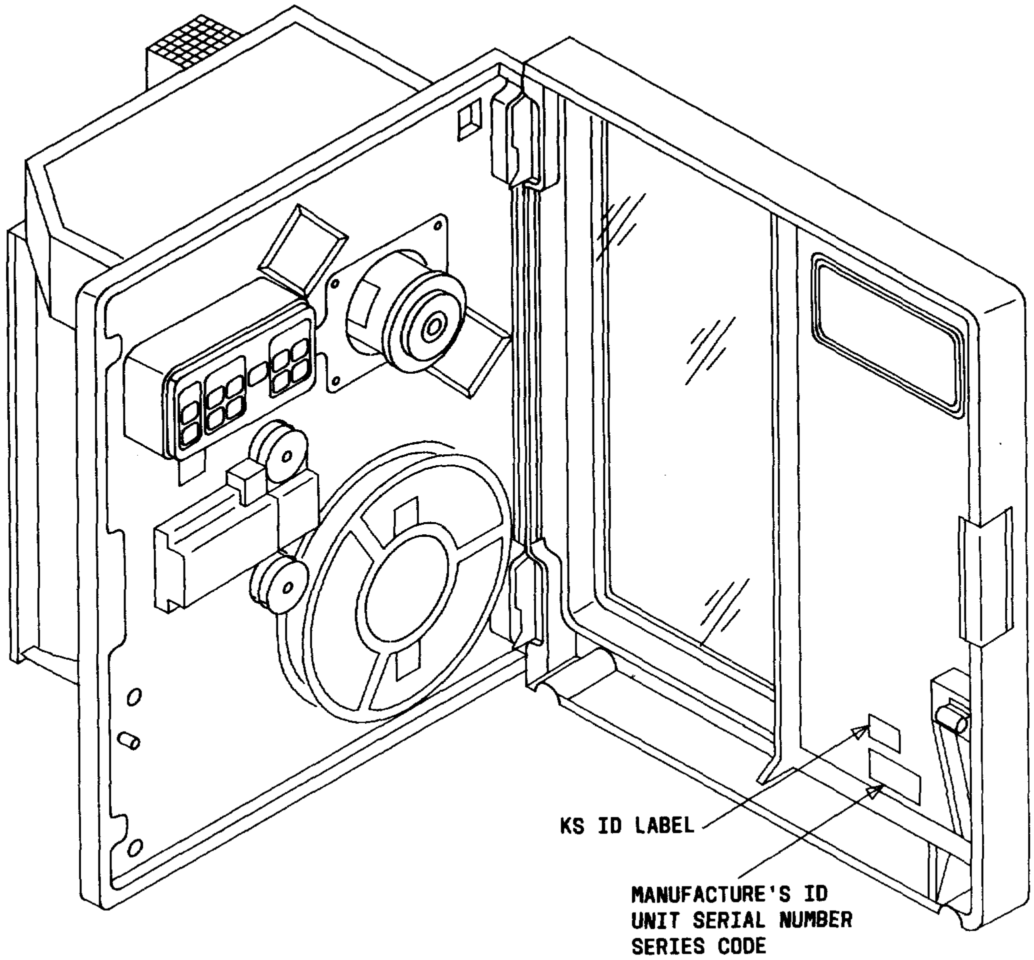


Fig. 3—KS-23113, L12 Tape Unit

logic. The write driver circuit converts the logic-compatible write data to the current levels required to drive the write head coils.

TAPE CLEANER

2.09 The tape cleaner assembly consists of two sapphire blades and a vacuum port. The sapphire blades are set such that one cleans tape in the forward direction and the other cleans tape in the reverse direction. The vacuum port draws off the debris removed by the cleaner blade.

CIRCUIT BREAKER

2.10 The circuit breaker is located at the top right corner of the tape deck. It is used as an overcurrent protective device for the power supply circuit. In the OFF posisiton, input power is removed from the power supply. To perform a power-up operation at the control panel, the circuit breaker must be on. The circuit breaker is rated at 10 amperes.

REEL MOTORS

2.11 The reel motors are conventional, permanent-magnet dc motors. The supply reel motor works in conjunction with the upper and lower air bearings. The supply reel motor and air bearings provide a control of tape tension across the recording surface of the magnetic head. The transducers sense the proximity of the tape over the air bearings via air pressure, and in effect, activate the servo. The transducers cause the servo to maintain a constant tension

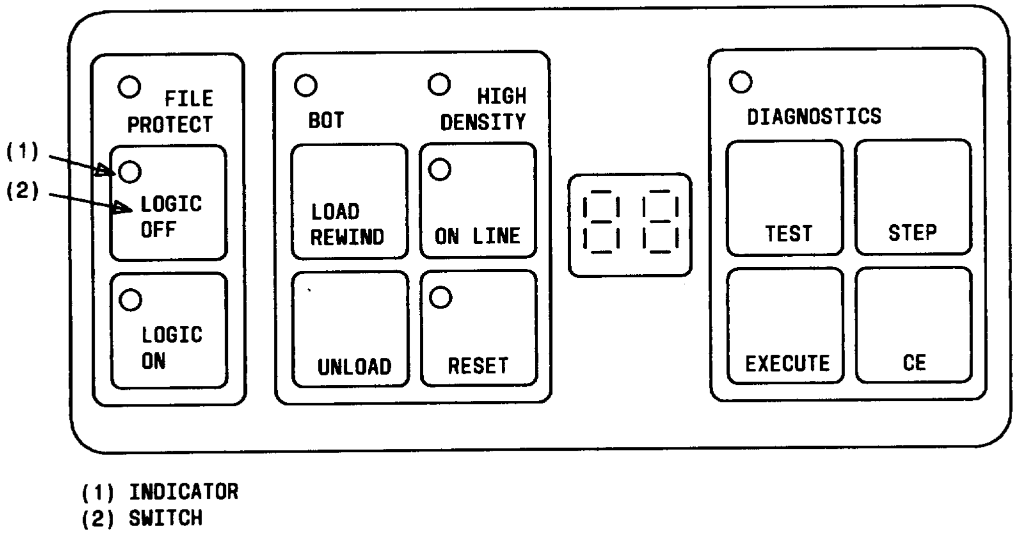


Fig. 4—Operator Control Panel

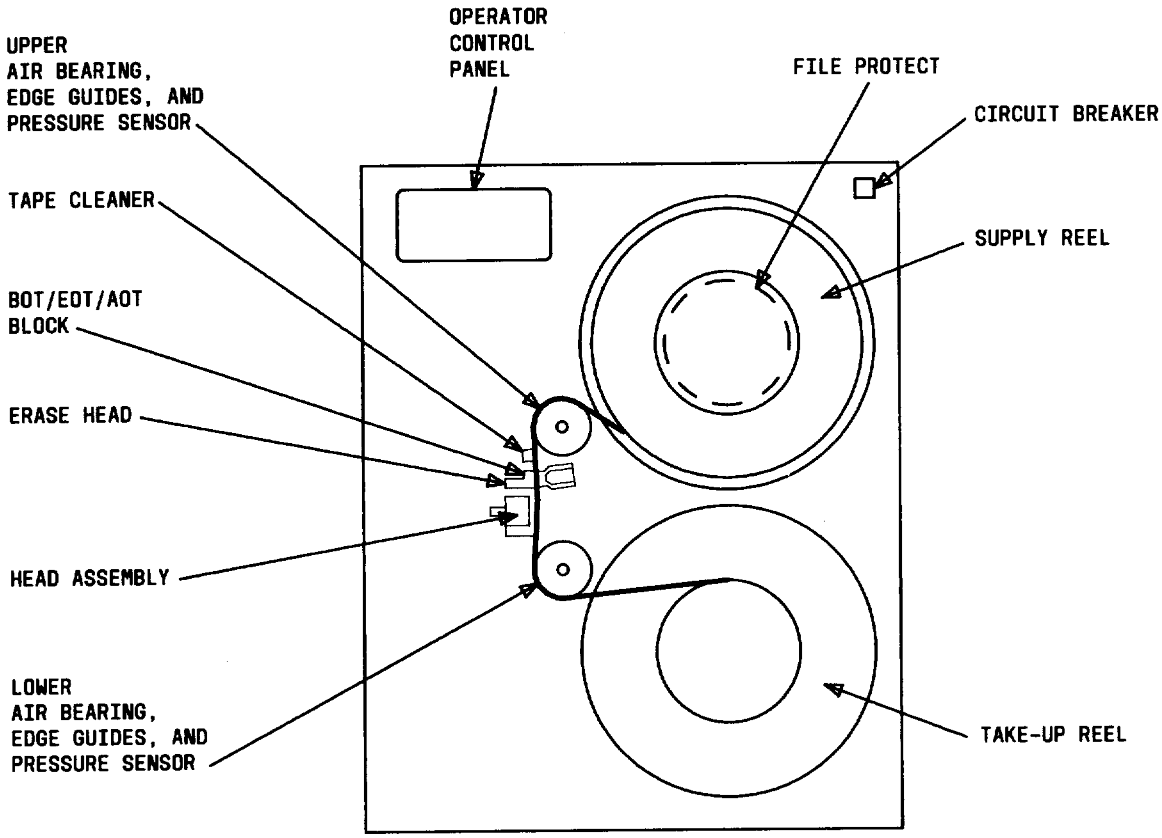


Fig. 5—Tape Deck (Front View)

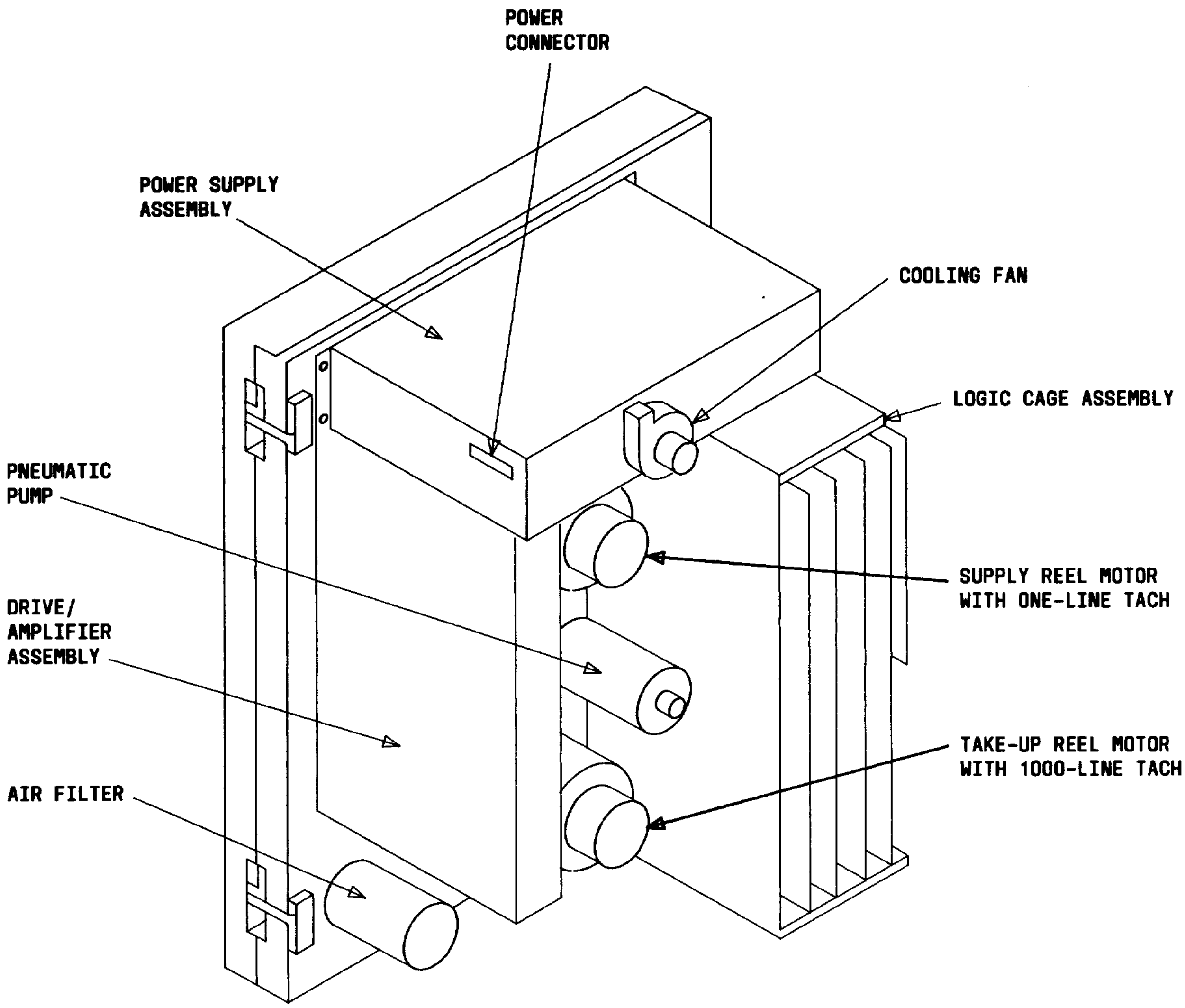


Fig. 6—Tape Deck (Rear View)

by increasing and decreasing the action of the supply reel motor.

POWER DRIVER AND AMPLIFIER ASSEMBLY

2.12 The power driver and amplifier assembly contains two identical power amplifiers. The first power amplifier drives the supply reel. The second power amplifier drives the take-up reel. Each power amplifier is a linear current amplifier that operates in pulse-width switching mode.

POWER SUPPLY ASSEMBLY

2.13 The power supply accepts the input line voltage and converts it to the required dc voltages. The power supply consists of a line filter, on/off circuit breaker, logic master clear circuit, pneumatic pump/motor control, cooling blower control, and voltage and current monitors.

PNEUMATIC PUMP/FILTER AND REGULATOR

2.14 The pneumatic pump is used to supply pressurized air for the air bearings. The pressure output is routed to a filter where any paritcles are removed before distribution to the air bearings. The vacuum portion of the pump draws air from the tape cleaner.

COOLING FAN

2.15 The cooling fan is a squirrel-cage type assembly which provides an air supply for cooling to insure high reliability of the logic circuitry, power amplifier, and power supply.

LOGIC CAGE ASSEMBLIES

2.16 The logic cage assemblies, at the rear of the tape deck, consists of six PC boards mounted into two separate logic cages. One logic cage contains the buffered interface, formatter write, and formatter read. The other logic cage contains the read, write, and servo control boards.

FORMATTER

2.17 The formatter is equipped with microprocessor-controlled circuitry. Its functions are primarily related to data operations. The microprocessor is constructed with the 6802 microprocessor chip being the basis. The 6802 microprocessor has two 8-bit accumulators, one 8-bit condition-code register, one 16-bit stack pointer, one 16-bit program counter, and one 16-bit register. The 6802 chip contains a 128-byte RAM (random access memory) and an internal clock. The clock provides timing for the microprocessor at the rate of 3.4 MHz. All inputs and outputs of the microprocessor board are TTL compatible.

READ/WRITE SERVO

2.18 The read/write servo performs many distinct functions with circuitry on one printed circuit board. The basic circuitries are:

- Microprocessor and associated hardware
- Servo for take-up and supply reels
- Head write drivers and write current programmable regulator
- Head read amplifiers with envelope detection and clip voltage generation circuits.

ADAPTER INTERFACE

2.19 The interface of the tape unit is based on the Industry Standard Interface for a half-inch tape product. The adapter interface is an MC6821 PIA (peripheral interface adapter). The PIA is a programmable device, which interfaces the 6802 microprocessor with the read/write control logic.

3. FUNCTIONAL DESCRIPTION

3.01 The tape unit is a manual-load, reel-to-reel tape drive unit. It uses electronically controlled servos to maintain tape tension and control the movement of the magnetic tape between the supply reel and the take-up reel.

3.02 ***Limitations:*** There are no restrictions on the number and sequence of forward, reverse, and rewind commands while the buffer interface circuit is disabled. However, it should be noted that diagnostic type sequences are not supported when the buffer is enabled.

3.03 ***Tape Creep:*** The transport is capable of standing indefinitely with power on with no tape movement.

3.04 ***Loss of Power:*** There is no physical damage to the tape in the event of power failure. Also, there is no damage to the recorded information when the supply reel is file protected or not protected in read mode. It is the system's responsibility to reset formatter enable before powering down.

> ***Note:*** Any data residing in the buffer interface circuit and not yet recorded will be lost.

3.05 ***Power-On/Load Feature:*** In the event that power is removed from the tape unit while tape is threaded, subsequent restoration of power to the tape unit will cause a load sequence to be initiated, terminating with the tape positioned at BOT and the tape unit being ON-LINE.

3.06 A functional block diagram of the tape unit is shown in Fig. 7. The tape unit consists of the following functional areas:

- Formatter-control logic
- Buffer interface circuit

- Read/write servo
- Read/write head assembly
- Pneumatic and cooling system
- Power supply and distribution.

FORMATTER/CONTROL LOGIC

3.07 The formatter/control logic is a microprocessor-controlled unit. It accepts commands and data from the central control and processes the signals into an acceptable form for the tape unit. During write operation, the formatter is capable of generating identification bursts, preambles, filemarks, phase encoded data, GCR encoded data, ECC (error correction), and CRC (cyclic redundancy) information, and postambles. In the read operation, the formatter is capable of detecting identification bursts, read data recovery, phase and GCR decoding, deskewing, buffering, single and double track error correction, and file mark detection.

3.08 Automatic single track "on-the-fly" error correction is performed using the vertical parity and track dropout pointers in PE mode. In GCR mode, two track error correction is performed using track dropout pointers and error correction information appended to the data during write operations.

3.09 A functional block diagram of the formatter/control logic is shown in Fig. 8. The 6802 microprocessor provides control functions for the unit. The PIA (peripheral interface adapter) interfaces the 6802 microprocessor with the associated circuits. The PIA 0 interfaces the formatter with the read/write servo board. The PIA 1 interfaces the 6802 microprocessor with the operator control panel. The PIA 2 interfaces the 6802 microprocessor with the peripheral controller. The PIA 3 controls the read logic and the PIA 4 controls the write logic on the formatter board. Thè PTM (progammable timer module) generates proper write clocks and a control line at preamble and postamble in the write operation. It also helps the microprocessor generate various amounts of delay during the read/write operations. The ROM (read-only memory) contains the functional and diagnostic program for the processor. It contains up to eight kilobytes of memory. The addressable latch and the multiplexer are used to increase the through-put capability of the processor.

READ/WRITE SERVO

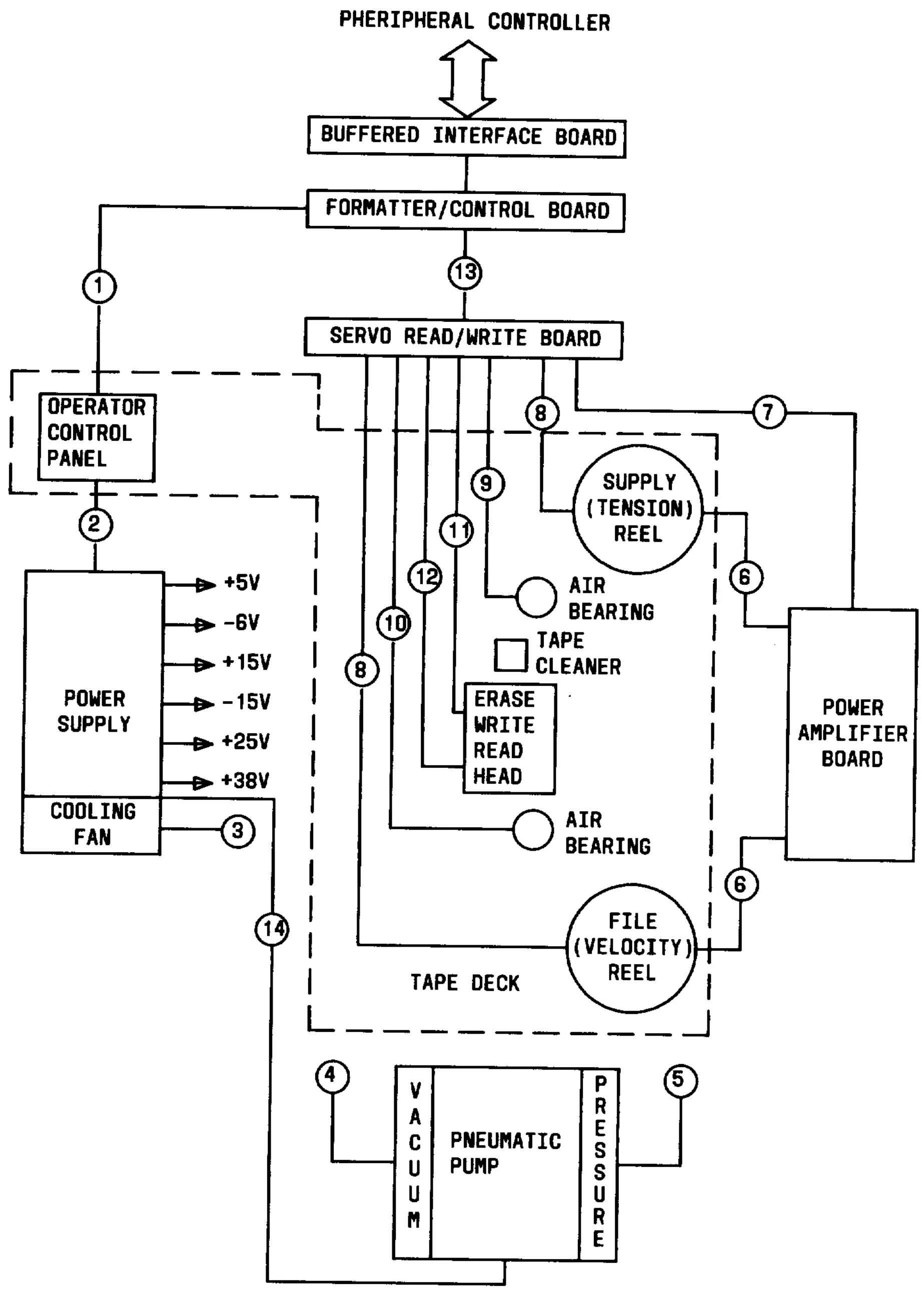
3.10 The read/write servo provides a control for the servo system. The servo system consists of the tension servo, velocity servo, read/write circuit, and magnetic heads. The read/write servo is made up of a microprocessor and associated hardware. The microprocessor is based on the 6802 microprocessor chip. The read/write servo receives commands and data from the formatter. It interprets these commands and passes the control signals or data to the demanding circuit. Refer to Fig. 9 for a block diagram of the read/write servo. The microprocessor is a central processing unit. The PROM (programmable read-only memory) contains the functional and diagnostic programs for the read/write servo. The EPROM (erasable PROM) provides a means of storing the read amplifier gain values and velocity servo offset multipliers. The PIA interfaces the read/write servo with the formatter. The PTM (programmable timer module) provides a real-time clock and enables the processor to count the servo tachometers. The bit input multiplexer and the output latches interface the microprocessor with the servo, read, and write hardwares. The tension servo provides a control for the take-up reel motor.

BUFFER CIRCUIT LOGIC

3.11 The buffered interface board is a microprocessor controlled unit containing a 128 kbyte memory used as a buffer for data transferring between the host and the tape media. The transfer rate between the buffer and the host controller variable (on-board switches) up to 750 kbytes/second.

3.12 The buffer board, in effect, emulates a start-stop tape drive, in that it is not necessary to send successive commands within a specified time in order for the drive to stream at a 75 IPS rate. During a write, the buffer is loaded by the host with the interface signals following a normal write command. When the buffer is loaded with blocks of data to a predetermined level, the buffer interface will initiate a write command to the drive and transfer of data from the buffer to tape commences in the streaming mode. As long as the buffer is not empty, the transfer continues.

3.13 Similarly, when the first read command is received by the buffer it initiates a read order to the drive, and data will be transferred to the buffer. As soon as the first block is in the buffer, it transfers



(1) OPERATOR/DIAGNOSTIC COMMANDS
(2) ON/OFF SWITCHES AND PANEL INDICATOR VOLTAGES
(3) COOLING AIR TO ALL ASSEMBLIES
(4) VACUUM SUPPLY TO TAPE CLEANER
(5) PRESSURE TO AIR BEARINGS
(6) DRIVE CURRENT TO REEL MOTORS
(7) SPEED/TENSION CONTROL
(8) TACH INFO TO SERVO CIRCUITS
(9) BEARING TRANSDUCER TENSION INFO
(10) BEARING TRANSDUCER VELOCITY INFO
(11) WRITE DATA TO TAPE
(12) READ DATA FROM TAPE
(13) LOGIC CONTROL AND FORMATTING INFO
(14) POWER TO PUMP MOTOR

Fig. 7—Tape Unit Functional Block Diagram

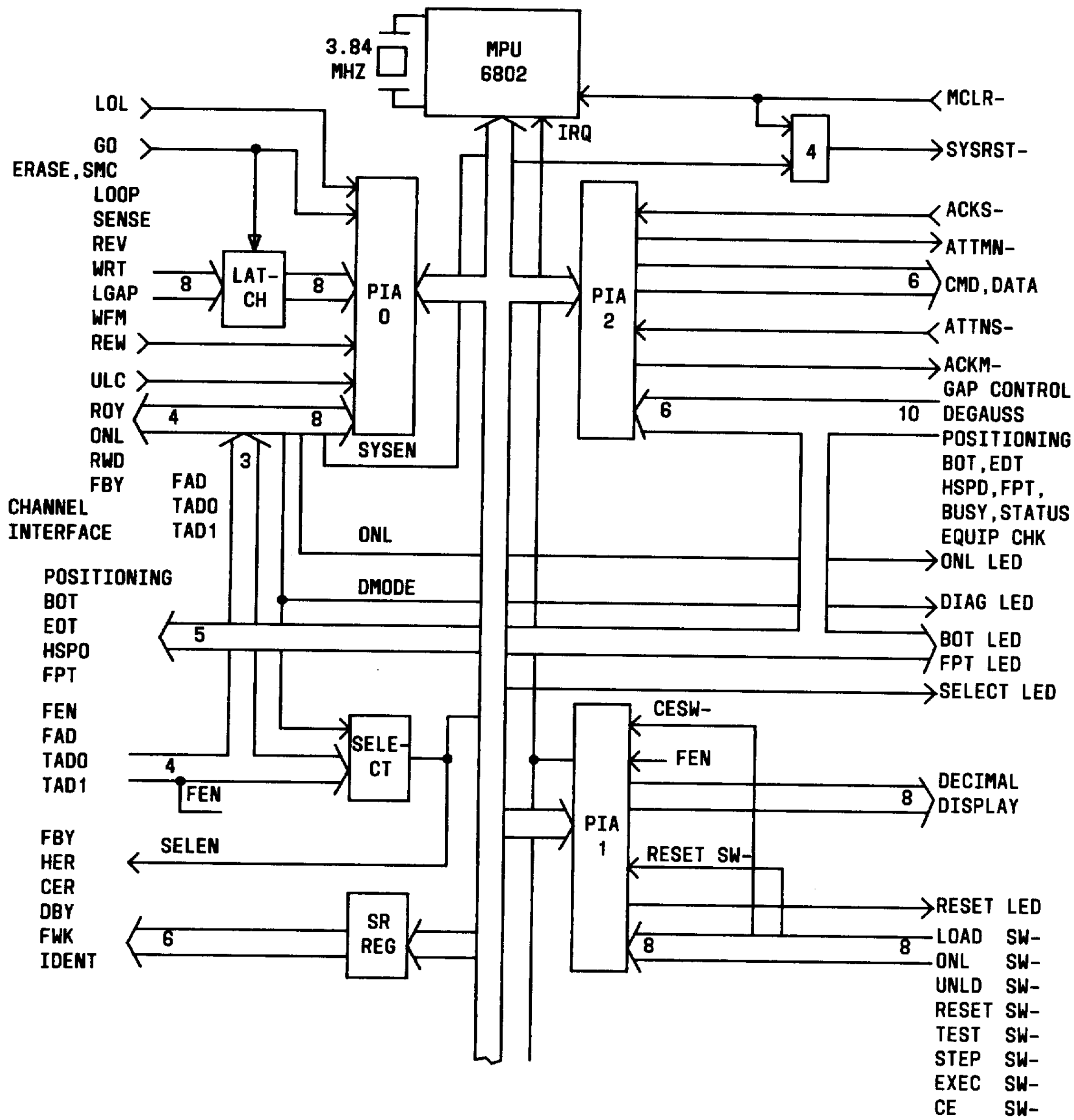


Fig. 8—Formatter/Control Block Diagram (Sheet 1 of 2)

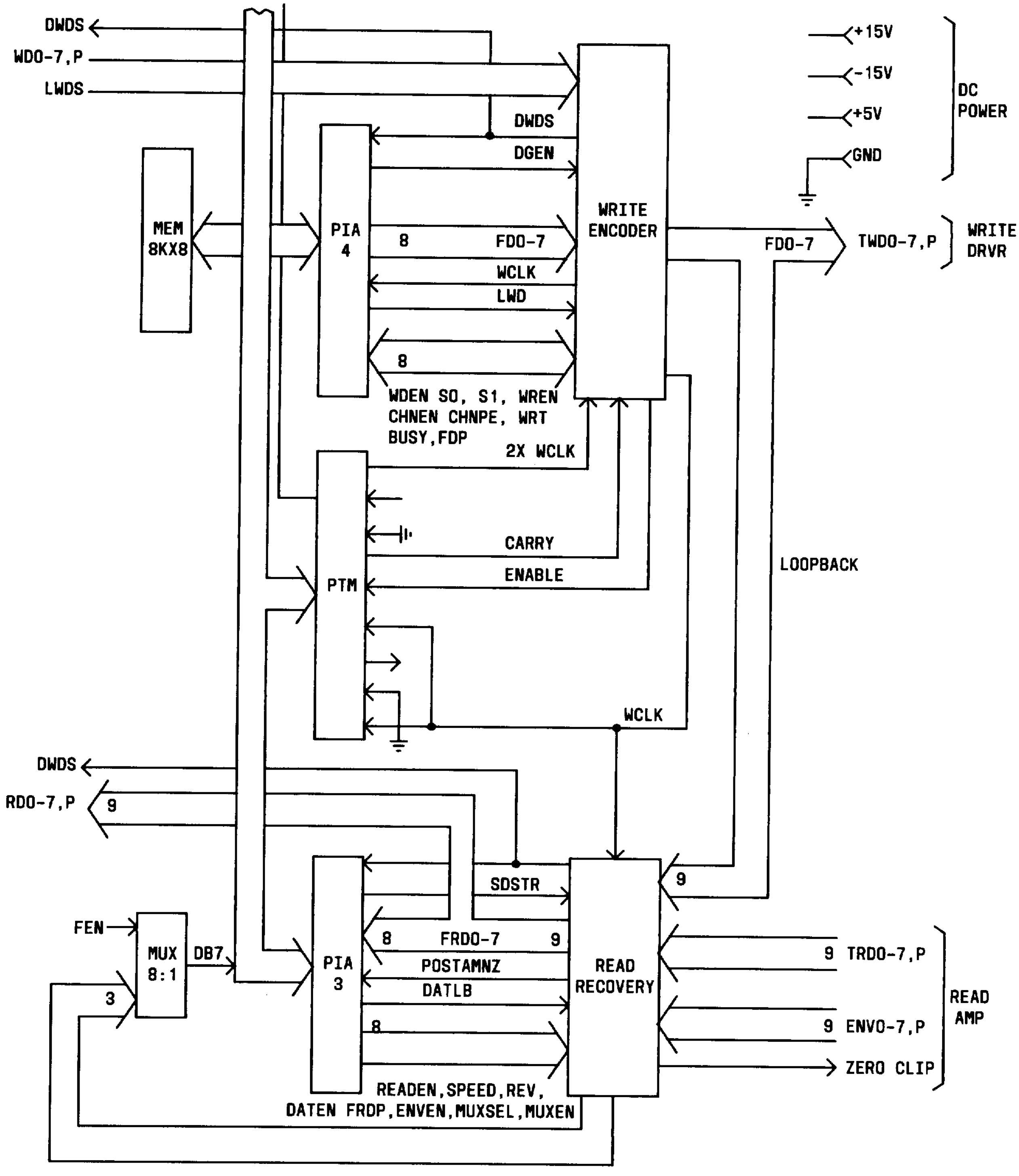


Fig. 8—Formatter/Control Block Diagram (Sheet 2 of 2)

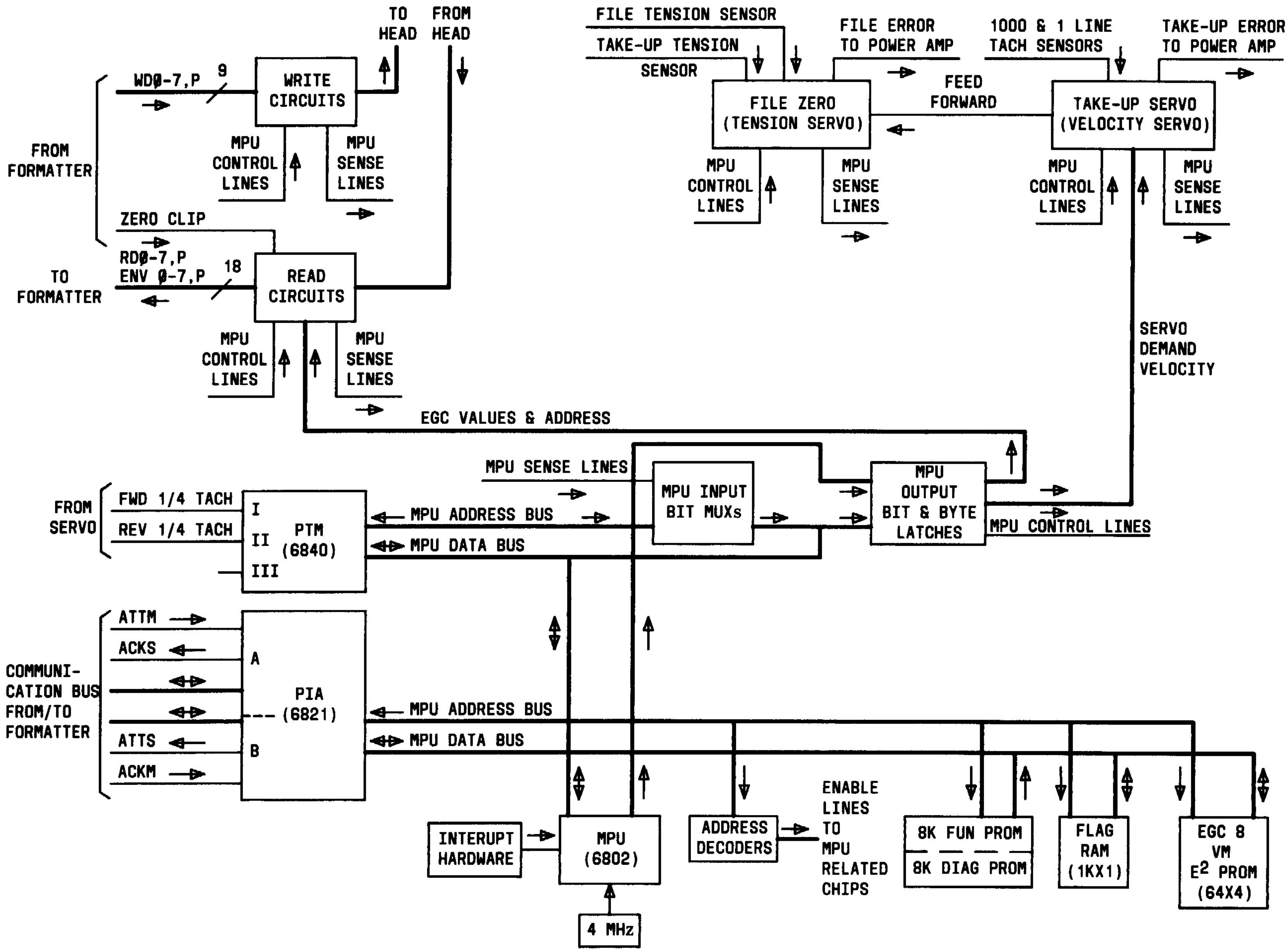


Fig. 9—Read/Write Servo Block Diagram

this data to the host controller. Anticipating that other read commands will be issued and to maintain streaming, the interface board will initate other read commands until the buffer is filled. As long as the host can empty the buffer faster than the drive can fill it, streaming continues.

3.14 Error correction is initiated by the buffer board if they occur. If retrys correct these errors on either writes or reads, the host does not find out that they occur. If they cannot be corrected in a given number of trys, the host is given a hard error (HER) signal.

OPERATOR CONTROL PANEL

3.15 The operator control panel (Fig. 4) includes switches, indicators, and a display, which are accessed from the front of the tape unit. The operator control panel is provided for manual control and diagnostic purposes. The functions of the switches and indicators are listed in Table A.

POWER SUPPLY

3.16 The power supply provides ac power for the cooling fan and pneumatic pump, generates dc power for the internal circuits of the tape unit, and provides shut-down capabilities in the event of abnormal voltage conditions. The power supply block diagram is shown in Fig. 10. The line filter is used to reduce electrical noise coming in with the input voltage. The circuit breaker provides an overcurrent protection for the tape unit. It is also used as a manual power control for the unit. The voltage select board can be reconnected to be used with 220-Vac input. The T1 transformer and rectifier provide standby voltages (+5V, +15V, and +20V direct current). The standby voltages are used only within the power supply. The +20 volts is used to develop the +15 volts and as a control voltage for the half-bridge switching converter and the control panel OFF indicator. The +15 volts (standby) is used as a supply voltage for the pulse-width modulation and K2 relay, and to develop the standby +5 volts. The +5 volts is used as a supply voltage for all TTL chips in the power supply. The CR9 triac and high-voltage rectifier accept 20-Vac input and then rectify and increase the 120 volts to approximately 300V direct current. The switching converter receives the 300 Vac input from the high-voltage rectifier. The pulse-width generator enables the switching converter to invert the 300 volts back to ac voltage via the T4 and T5 transformers. The rectifier and regulators rectify the ac outputs from the T4 and T5 transformers into +5V, −6V, ±15V, +25V, and +38V direct current. The +5V direct current is supplied to TTL circuits. The −6V direct current is supplied to the read amplifier circuits. The −15V direct current is supplied to the servos and power amplifier. The +15V direct current is supplied to the servos, power amplifier, and read recovery circuit. The +25V direct current is supplied to the write driver circuits. The +38V direct current is supplied to the power amplifier.

POWER AMPLIFIER

3.17 The power amplifier accepts control signals from the read/write servo and provides current amplifications and overvoltage/undervoltage protections for the reel motors. The power amplifier consists of the following components:

- Triangular wave generator
- Bridge circuit for each reel motor
- Overvoltage/undervoltage protection
- Amplifiers and summing circuits
- Comparators and drivers.

A. One-Quadrant Operation

3.18 Refer to the power amplifier block diagram in Fig. 11. The error ampifier receives the analog signals (ERR and ERR RTN) from the formatter. The signals are isolated to eliminate the common ground between the power amplifier and the formatter. The isolated input signal (ERR) is summed with the negative current feedback (ICW and ICCW). The ratio of summation is 1-ampere output per 1-volt input. The summation amplifier amplifies the summed signal (ERROR) by a factor of 10. The inverted and noninverted signals are applied to two comparators along with a common triangular wave for developing pulse-width modulated signals. The driver drives the pulse-width signal to both sides of the bridge circuit. Te bridge circuit operates in five different modes. The durations of the pulse-width signal are used to determine the state of the bridge circuit. The bridge cirucit (Fig. 12) consists of four transistors (Qa, Qb, Qc, and Qd) and four diodes (CRa, CRb, CRc, and CRd). In state 1, transistors Qa and Qc are activated. At the same time, transistors Qb and Qd are turned

TABLE A

OPERATOR CONTROL PANEL

SWITCH	INDICATOR	FUNCTION
LOGIC OFF		If pressed when the tape unit is powered on, power will be removed from the tape unit and the LOGIC OFF indicator will light.
	LOGIC OFF	When lighted, indicated a standby power condition.
LOGIC ON		If pressed when the transport circuit breaker is on, the tape unit is powered on.
	FILE PROTECT	When lighted indicates the absence of a write enable ring in the supply reel and write operation is inhibited in the tape unit.
	BOT	When lighted, indicates that the tape is positioned at the beginning of tape (BOT).
LOAD/REWIND		If the transport is powered on and tape is threaded, depressing the switch causes a load operation to be performed. If tape is loaded, depressing the switch causes a rewind operation to the BOT.
UNLOAD		If tape is loaded, depressing the switch causes the tape to unload from the take-up reel to the supply reel. If tape is threaded but not leaded, depressing the switch will cause the unit to slowly unload the tape onto the supply reel.
ON-LINE		If tape is loaded, depressing the switch causes the transport to go on-line and to become available for the system control.
	ON-LINE	When lighted, indicates that the tape unit is on-line.
RESET		Used to take the unit off line, stop tape motion, and clear error status. Certain control faults require a power-off or power-on sequence to clear.
	RESET	When lighted, indicates that a tape unit error condition exists.
	HIGH DENSITY	When lighted, indicates that the unit is in the GCR mode.

TABLE A (Contd) OPERATOR CONTROL PANEL		
SWITCH	INDICATOR	FUNCTION
	TWO-DIGIT DISPLAY	The 2-character display is lighted when the tape unit is in off-line diagnostic/test mode. It displays diagnostic/test sequence numbers and results of tape unit microdiagnostic or exerciser routines when the tape unit is in off-line diagnostic/test mode. When the reset indicator is lighted, it displays either a diagnostic fault code or an on-line operational failure code.
	DIAGNOSTIC	When lighted, indicates that the unit is in the diagnostic/-test mode.
TEST		Used to place the tape unit into a diagnostic/test mode when it is not on-line.
STEP		If the unit is in a diagnostic/test mode, the diagnostic/test sequence numbers can be entered by depressing this switch.
EXECUTE		If the tape unit is in a diagnostic/test mode, depressing the switch will initiate the microdiagnostic shown on the 2-digit display.
CE		If the tape unit is in a diagnostic mode, depressing the switch will initiate special microdiagnostics.*

* Diagnostics should be performed by trained personnel.

off. In state 2, the transistor Qa is turned off while thr transistor Qc is still on. State 2 occurs when the motor current is greater than the ERR input. In state 3, transistors Qb and Qd are activated while transistors Qa and Qc are turned off. The current of the motor in state 3 is in the opposite direction from the current of the motor in state 1. In state 4, transistor Qd and diode CRc are activated while transistors Qa, Qb, and Qc are turned off. The capacitor discharges current through diode CRd to the motor. The current from the motor returns to the capacitor via diode CRb.

B. Change of Quadrant

3.19 The error signal changes quadrant or sign when the input ERR voltage becomes less than the motor current. The change of sign causes two operations. In the first operation, the sign value, existing as 0 or 1, controls the bridge transistors (Qc and Qd) and gates the comparator signals (CW/CCW) to the bridge transistors (Qa and Qb). In the second operation, all four transistors (Qa, Qb, Qc, and Qd) are inhibited from conduction for 50 microseconds. Refer to Fig. 12. In this illustration, state 5 exists. After 50 microseconds, the motor current drops below the ERR input so that states 1 and 2 are reactivated. If, within the 50-microsecond period, the motor current does not fall below the ERR input, transistors Qb and Qd will conduct and continue to decrease the motor current. This condition exists when the ERR input has changed very rapidly or greatly in the opposite direction of the existing current.

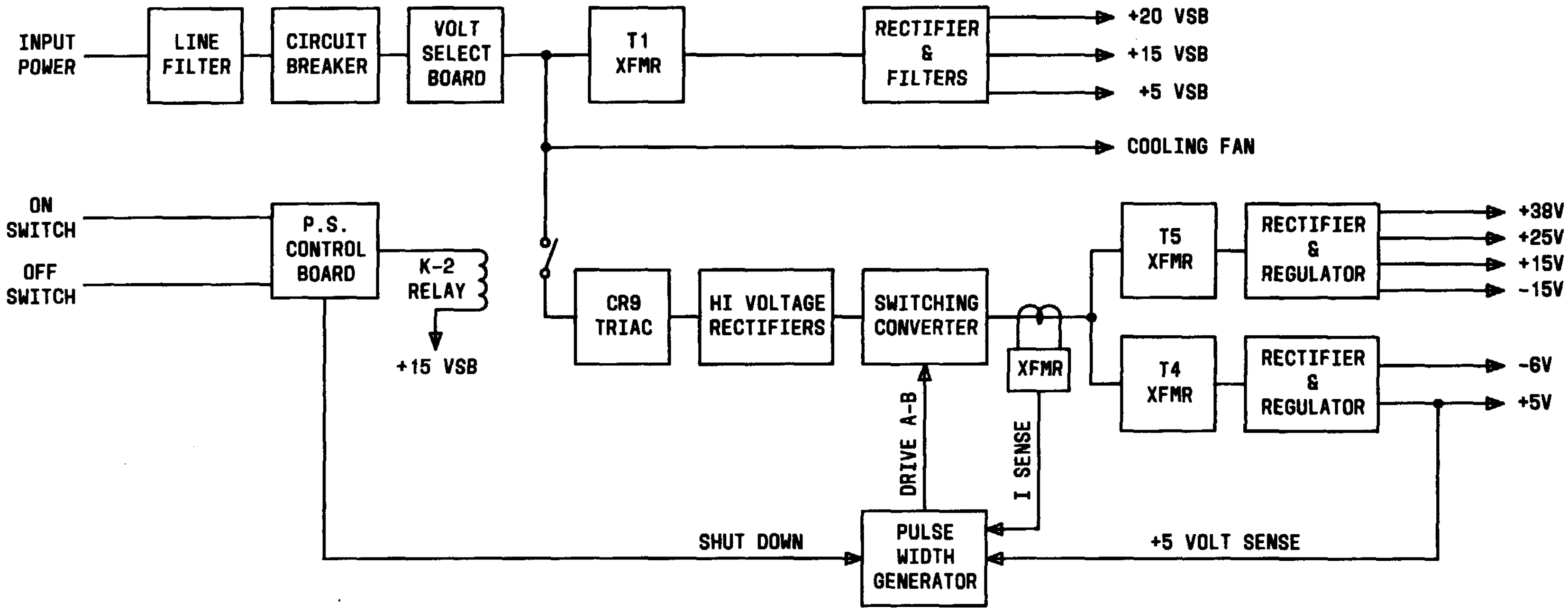


Fig. 10—Power Supply Block Diagram

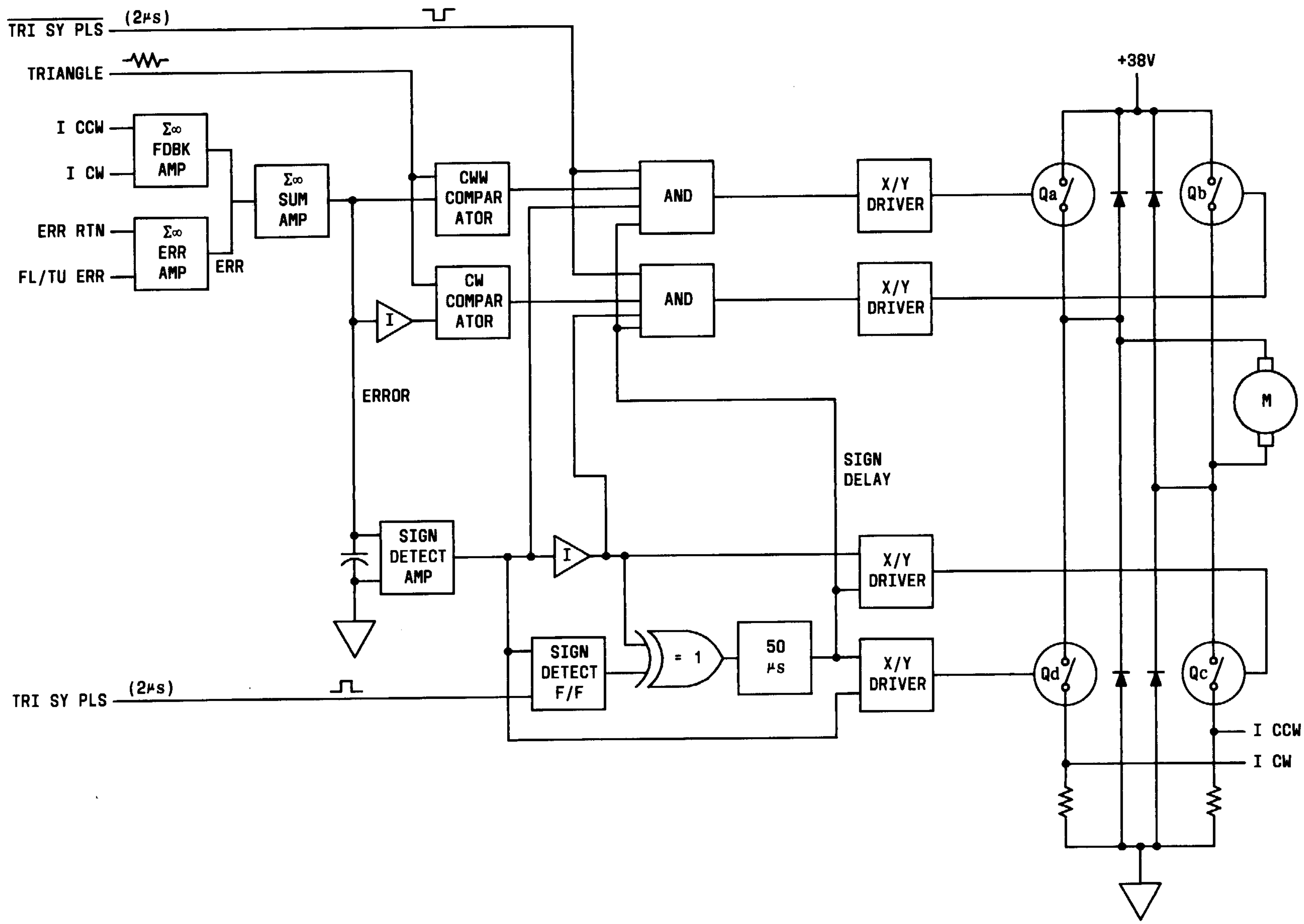
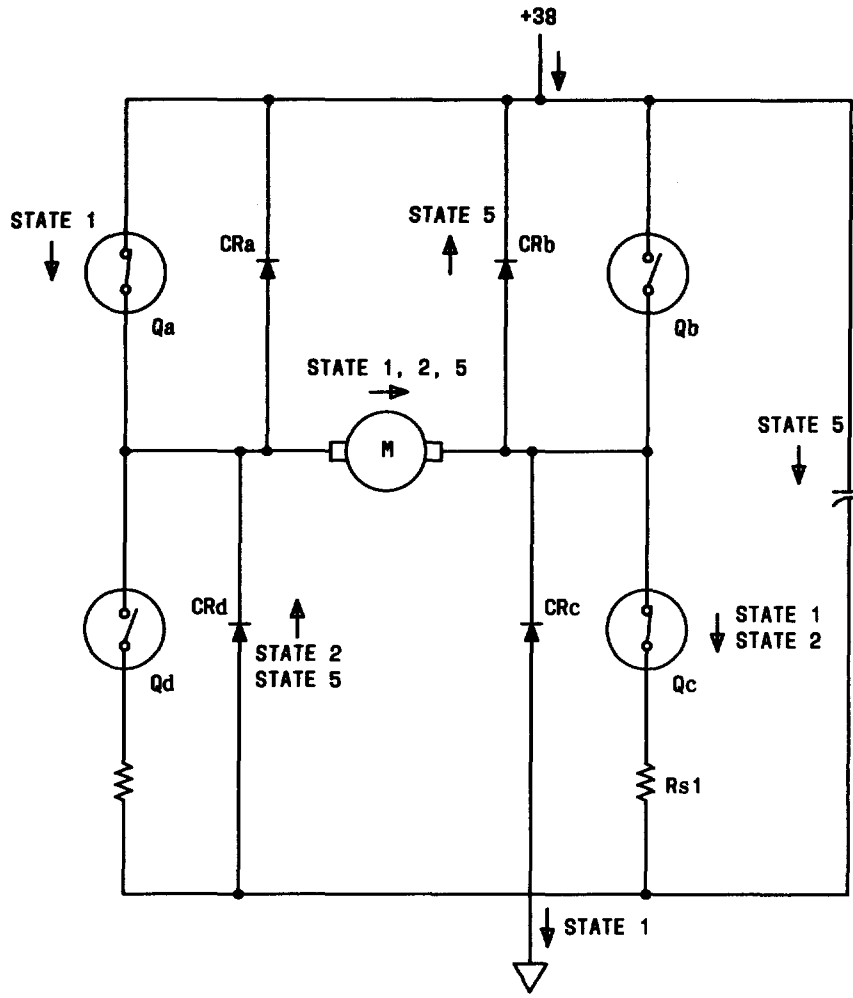


Fig. 11—Power Amplifier Block Diagram



STATE	ACTIVE COMPONENTS
1	Qa → M → Qc
2	M → Qc → CRd → M
3	Qb → M → Qd
4	M → Qd → CRc → M
5	C → CRd → M → CRb → C

Fig. 12—Bridge Circuit

PNEUMATIC SYSTEM

3.20 The pneumatic system (Fig. 13) generates and distributes the air pressure and vacuum to the tape unit. The pneumatic system consists of a carbon vane centrifugal pump, tape cleaner intake port, tape deck plenum, filter and regulator assembly, and pressure ports of the air bearings. The vacuum effect at the tape cleaner is approximately 8 inches of water. The air pressure at the air bearings is 2 pounds PSI (per square inch). The filter and regulator assembly cleans and maintains the air pressure at 2 PSI and distributes it to the air bearing.

A. Air Bearings

3.21 The air bearings provide an air cushion allowing tape tension control over the record and playback surface of the magnetic head. Both upper and lower air assemblies provide guidance of the tape across the magnetic heads.

B. Tape Cleaner

3.22 The tape cleaner assembly consists of two sapphire blades and a vacuum port. The sapphire blades are set so that one cleans tape in the forward direction and the other cleans tape in the reverse direction. The vacuum port draws off the debris that is removed by the cleaner blade.

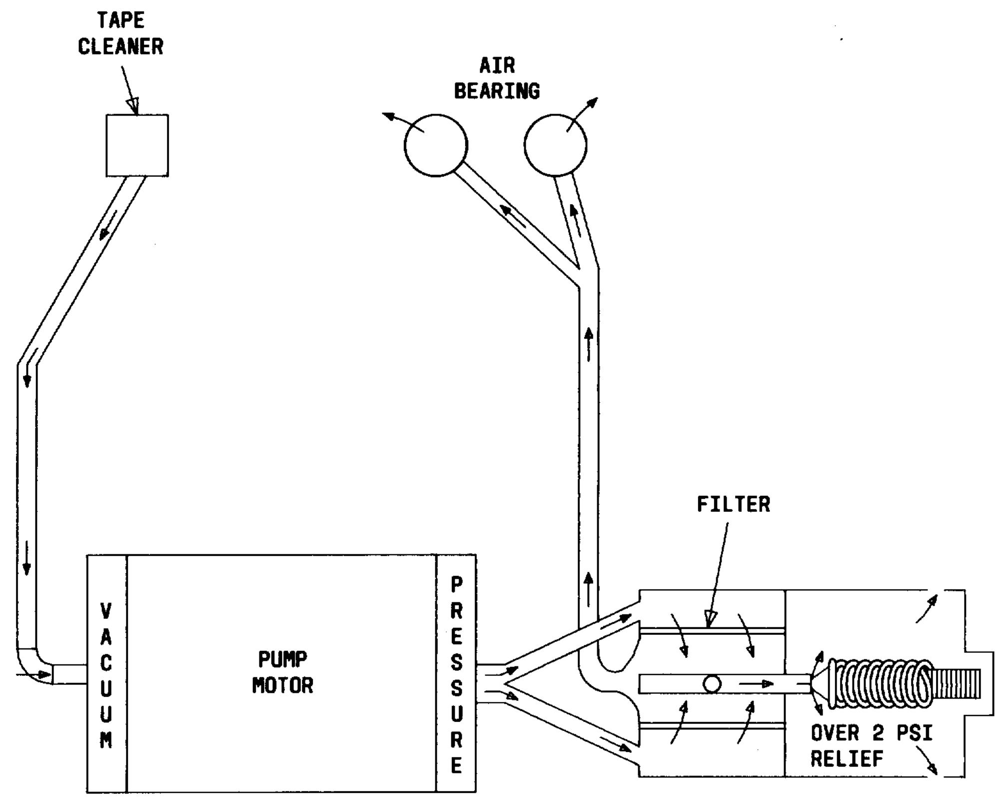


Fig. 13—Pneumatic System

C. Pneumatic Pump, Filter, and Regular

3.23 The pneumatic pump is an ac induction motor with a 4-blade pump. The pressure output is routed to the filter via the deck casting where any particles are removed before distribution to the air bearings. The piston-type pressure regulator, which maintains a constant pressure to the upper and lower air bearings, is mounted directly onto the filter. The vacuum portion of the pump draws air from the tape cleaner. The wiring diagram of the pump motor is shown in Fig. 14.

4. THEORY OF OPERATION

GENERAL RECORDING REQUIREMENTS

4.01 The format of recording is 1600 bits per inch in the PE (phase encoded) method and 6250 bits per inch in the GCR (group coded recording) method. This format meets the qualifications of the ANSI (American National Standard Institute), Article X3.39-1793. Characteristics of the recorded tape are provided in Table B.

A. Reflective Tape Markers

4.02 Every reel of magnetic tape must have a BOT (beginning-of-tape) and EOT (end-of-tape) reflective marker so that the transport can recognize starting and stopping areas. Tapes are always supplied with reflective markers installed. However, if the markers become detached for any reason or if the tape leader is shortened because of tape damage, the operator must install a marker as shown in Fig. 15.

B. System and Timing Considerations

Motion Characteristics

4.03 The tape unit has two operational speeds: 25 inches per second and 75 inches per second. Selection of either speed is made at the tape unit interface (the UN145 controller). The speed of 25 inches per second is a default mode. At a speed of 75 inches

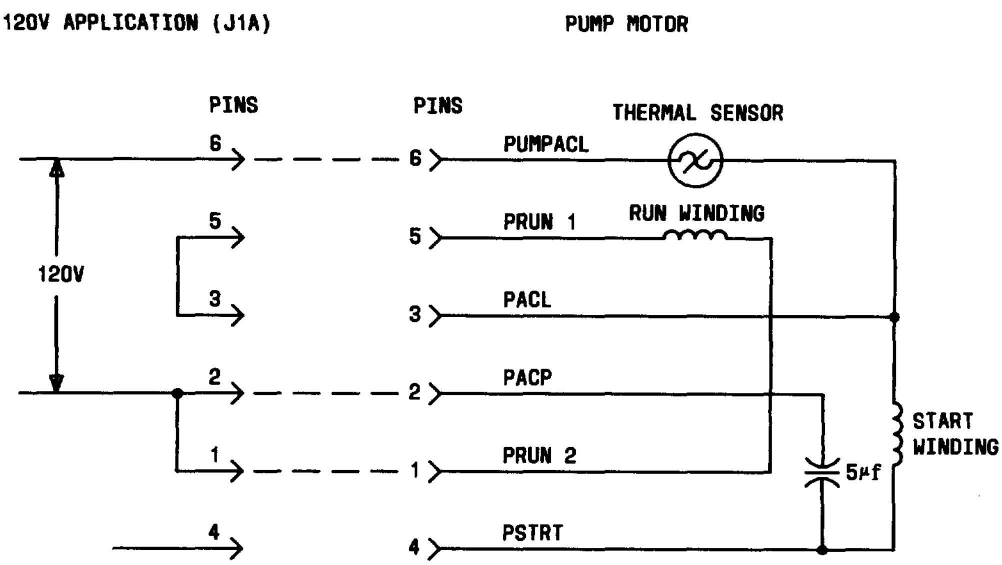


Fig. 14—Pump Motor Wiring Diagram

per second, the tape unit only performs in the streaming mode. At the speed of 25 inches per second, the tape unit either performs in the start/stop or streaming mode.

Start/Stop Mode

4.04 In the start/stop mode (Fig. 16), the tape unit operates similarly to a conventional half-inch tape unit. It accelerates the tape when it receives a command and stops the tape within the IBG (interblock gap). A long IBG of 1.2 inch nominal in PE mode or 0.6 inch nominal in GCR mode may be commanded as well as the normal or 0.7 inch nominal IBG in PE mode or 0.4 inch nominal in GCR mode. The start/stop mode includes the following operations:

- Read operation
- Write operation
- Other start/stop motion. In the start/stop mode, the tape will stop between records regardless of reinstruction timing.

4.05 ***Read Operation:*** During the read operation cycle, after a block has been successfully traversed, the tape will be brought to a complete stop to await the next command. The microprocessor, which resides in the read/write servo board, will delay the subsequent commands if the time since the last start is less than 80 milliseconds.

4.06 ***Write Operation:*** In the write operation, the controlled operation is the same as in the read operation. The 80-millisecond restriction is still applied. The normal interblock gap in this mode is 0.7 inch in PE mode and 0.4 inch in GCR mode.

4.07 ***Other Start/Stop Motion:*** Whenever a change from read to write is experienced, a job operation is performed in order to position the erase within the interblock gap. The time to execute the jog operation is normally 191 milliseconds. When changing from write to read reverse or rewind, a forward jog to erase a full gap is inserted by the transport. This insures that there will be no glitch in the initial gap when the write head is turned off. Time to execute the forward jog is 120 milliseconds.

Streaming Modes (25 IPS And 75 IPS)

4.08 The streaming modes are high performance operating modes designed to accommodate contiguous transfers of many data blocks to or from tape. Unlike the start/stop mode, tape acceleration and deceleration cannot be accomplished within the IBG. In order to efficiently utilize the streaming mode, tape motion must be sustained by commanding

TABLE B

STREAMING TAPE UNIT OPERATIONAL PERFORMANCE SUMMARY

PARAMETER	UNIT OF MEASURE
Tape Velocity (Long Term)	inches per second
High Speed	75 (Note 1)
Low Speed	25
Long Term Speed Variation	3% Maximum (Note 2)
Short Term Speed Variation	5% Maximum (Note 2)
Recording Density	bits per inch
GCR	6250
PE	1600
Channel Data Transfer Rate (Burst Rate, Buffer Enabled)	kilobytes per second
Maximum Selectable	750
Minimum Selectable	62.5
Channel Data Transfer Rate (Average Overblock, Buffer Disabled)	kilobytes per second
GCR	
High Speed	469
Low Speed	156
PE	
High Speed	120
Low Speed	40
Tape Tension	ounces 8.0
Load Time	seconds 15 Maximum (Note 3)
Access Time (Note 4) (GCR Mode, Buffer Disabled)	milliseconds
High Speed Streaming	
Write	150
Read	154
Low Speed Streaming	
Write (After Write	58
Read (After Read)	54
Write (After Read)	178
Low Speed (Start/Stop)	
Write	22
Read	24

TABLE B (Contd)

STREAMING TAPE UNIT OPERATIONAL PERFORMANCE SUMMARY

PARAMETER	UNIT OF MEASURE
Access Time (Note 4)	milliseconds
(PE Mode, Buffer Disabled)	
High Speed	
Write	154
Read	158
Low Speed (Streaming)	
Write (After Write)	70
Read (After Read)	66
Write (After Read)	190
Low Speed (Start/Stop) (Note 5) (Note 11)	
Write	22
Read	24
Interblock Gap Size	inches
Write	
PE Mode	
Short Gap (Fixed)	
Low Speed Streaming (Note 7)	0.6 to 0.7
Low Speed Start/Stop (Note 7)	0.7
High Speed	0.6
Short Gap (Variable) (Note 8)	0.6 to 0.9
Long Gap (Fixed)	1.2
Long Gap (Variable) (Note 8)	0.6 to 1.2
GCR Mode	
Short Gap (Fixed)	
High Speed Streaming	0.3
Low Speed Streaming	0.3 to 0.45
Short Gap (Variable)	0.3 to 0.45
Long Gap (Fixed)	0.6
Long Gap (Variable)	0.3 to 0.6
Start/Stop	0.4
Start/Stop (Fixed Long Gap)	0.6
Minimum Read Gap Supported (Notes 9 & 10)	
PE Mode	0.5
GCR Mode	0.28
Positioning Time (Note 11)	milliseconds
High Speed	430
Low Speed	155
Reposition Time (Note 12)	milliseconds
Low Speed GCR	209
Low Speed PE	221
High Speed GCR	584
High Speed PE	588

TABLE B (Contd) STREAMING TAPE UNIT OPERATIONAL PERFORMANCE SUMMARY	
PARAMETER	**UNIT OF MEASURE**
Rewind Time For 2400 Foot Tape On 10.5 Inch Reel	minutes 2.5
Maximum Block Size Jumper selectable from 8K to 64K in 8K increments when buffer is enabled. 64K when buffer is disabled.	
Start/Stop Times High Speed Streaming Low Speed Streaming Low Speed Start/Stop (PE) Low Speed Start (GCR) Low Speed Stop (GCR)	milliseconds 120 40 20 20 60
Command Reinstruct Times (Buffer Disabled) (Notes 13, 14, & 15)	

	Fixed Long		Variable Long		Fixed Short		Variable Short	
	WRITE	READ	WRITE	READ	WRITE	READ	WRITE	READ
75 IPS GCR	5.5ms	7.5ms	5.5ms	7.5ms	1.5ms	7.5ms	3.5ms	7.5ms
25 IPS GCR	17.5ms	23.5ms	17.5ms	23.5ms	5.5ms	23.5ms	11.5ms	23.5ms
GCR Start/Stop	7.5ms	0.0ms	0.0ms	0.0ms	0.0ms	0.0ms	0.0ms	0.0ms
75 IPS PE	13.5ms	15.5ms	13.5ms	15.5ms	5.5ms	15.5ms	9.5ms	15.5ms
25 IPS PE	41.5ms	47.5ms	41.5ms	47.5ms	17.5ms	47.5ms	29.5ms	47.5ms
PE Start/Stop	19.5ms	0.0ms	0.0ms	0.0ms	0.0ms	0.0ms	0.0ms	0.0ms

TABLE B

STREAMING TAPE UNIT
OPERATIONAL PERFORMANCE SUMMARY

Notes:

1. Speed will always be 75 IPS when buffer is enabled.

2. Meets both steady-state and short term velocity tolerances as defined by ANSI X3.39-1973 for 1600 CPI phase encoded recording and ANSI X3.40-1976 for 6250 CPI GCR encoded recording.

3. The BOT marker is assumed to be on the file reel side of EOT/BOT sensor and placed on tape leader in accordance with ANSI X3.39-1973.

4. The time from a stopped state to the transfer of the first byte of data to or from the tape.

5. In PE start/stop mode, the tape will be brought to a full stop after each record regardless of the reinstruct period.

6. If the previous Read or Write command occurred less than 80 ms prior to new command, this time will be increased by the difference between 80 ms and the actual time since the previous Read or Write.

7. The STU automatically switches from low speed streaming mode to low speed start/stop mode when the host system cannot maintain the unit effectively streaming. Since the write gap in start/stop mode is nominally 0.7 inch, the unit will automatically extend IBG to 0.7 inch in streaming mode so as to avoid unnecessary throughput degradation. To keep the unit streaming, the system must reinstruct within 21.5 ms (0.7 inch gap) and, if reinstruct occurs within 17.5 ms, a 0.6 inch gap will be written; between 18 ms and 22 ms gaps greater than 0.6 inches and less than 0.7 inch will be written.

8. The STU streaming mode write operation has optional record gaps selected on a printed circuit board. In PE mode, the following applies. In the short gap mode the record gap will either be fixed at 0.6 inch or variable 0.6 to 0.9 inch. In the long gap mode the record gap will be fixed at 1.2 inches or variable 0.6 to 1.2 inches. In GCR mode, the following applies. In the short gap mode, the record gap will be fixed at 0.3 inch or variable 0.3 to 0.45 inch. In the long gap mode, the record gap will be fixed at 0.6 inch or variable 0.3 to 0.6 inch. The STU is shipped with the settings in the variable modes.

9. Unit will read minimum ANSI gaps in all modes.

10. In streaming modes, the unit will reposition if no reinstruct is received before the next block is encountered or, if the tape has moved 1.2 inches in PE mode or 0.6 inch in GCR mode (this is independent of unit gap selection).

TABLE B (Contd)

STREAMING TAPE UNIT
OPERATIONAL PERFORMANCE SUMMARY

Notes:

11. This is the total time required to recover from a command over-run and return to stopped condition to await next operation.

12. This is the total time required for accessing first byte of data for a command received immediately after command reinstruct time when the buffer is disabled.

13. This is the total elapsed time from completion of a command execution to the latest point in interrecord gap, at which the STU can accept another command without a recovery cycle.

14. The STU in high speed streaming mode has optional record gap lengths. In PE mode, the reinstruct times for a Write reflect a 0.6 inch normal gap, or a 0.9 inch variable gap, or a 1.2 inch variable or fixed long gap. In GCR mode, the reinstruct times for a Write reflect a 0.3 inch normal gap or a 0.45 inch variable gap, or a 0.6 inch variable or fixed long gap. During a Read, the reinstruct times reflect the long gap. If a block is detected before the command is received, the STU will reposition. If the command is received before the next block is detected, the STU will read the next record without reposition.

15. While writing a long gap, the tape will be brought to a full stop if a command of the same type is not received during the reinstruct period.

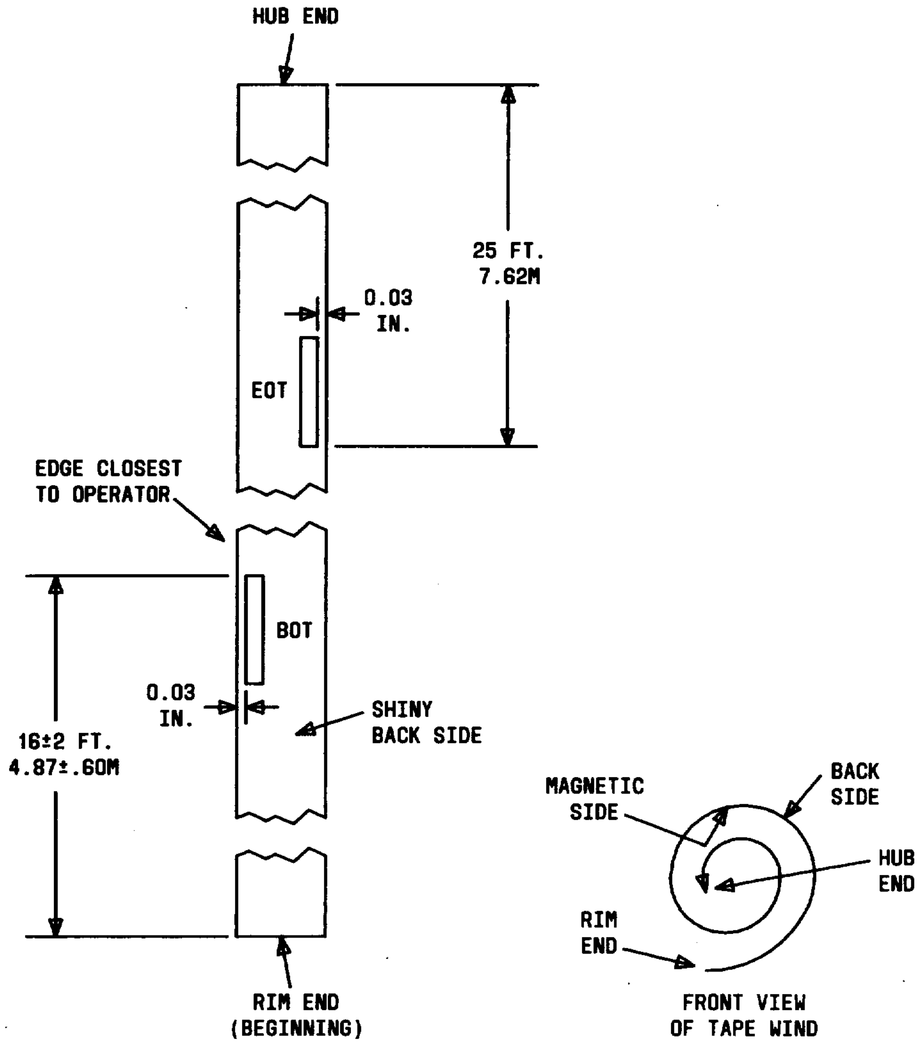


Fig. 15—Location of Reflective Markers

successive data operations. This is accomplished by issuing subsequent commands to the STU during the time the STU is traversing the IBG. (This command window is referred to as the command reinstruction time.) Should a follow-up command not be received during the reinstruction interval, a repositioning cycle is required. The interface buffer allows more data records to be prestored so that the STU will not have to stop if the next command is late. (A reverse command can be received during the initial down ramp and reverse ramp up, and will be executed without going through the complete repositioning cycle.) By way of illustration, consider this 75 IPS case. Assume that the STU is in PE mode and has just completed a write data operation; if the normal IBG length of 0.6 inch is commanded by the system, then the system has 6.0 ms to respond with a subsequent write command in order for streaming mode to be sustained. If the subsequent write command is not received by the end of the reinstruction interval, the STU will reposition itself in anticipation of the next streaming mode command. Repositioning cycle times are defined in Table B for the various modes of operation selected.

4.09 There are three sequences of events which generally describe the motion characteristics

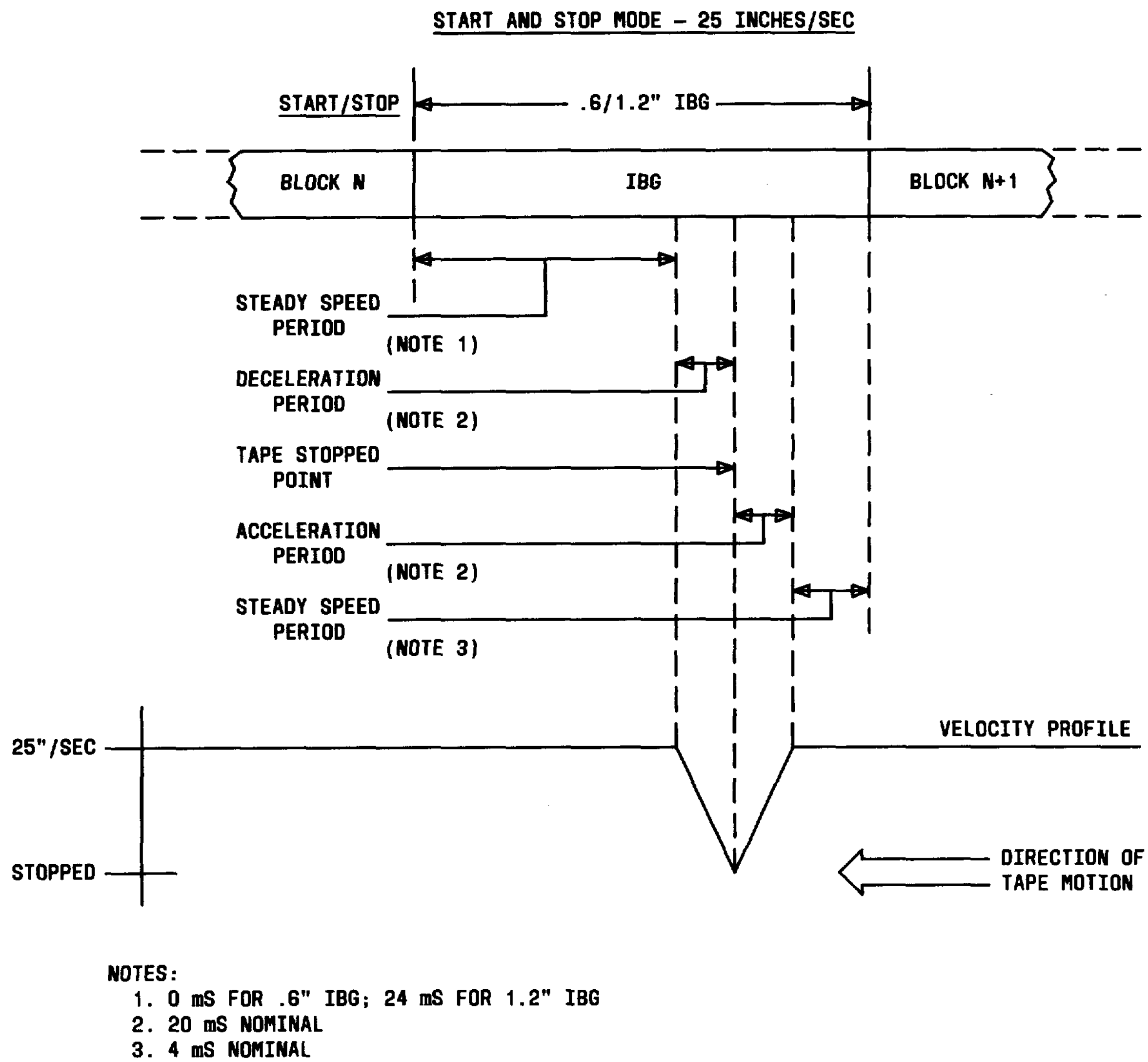


Fig. 16—Start/Stop Mode Tape Motion Control

of the STU in the streaming mode. These sequences are:

- Command Received During Reinstruction Interval
- Command Received During Repositioning Cycle
- Command Received Following Repositioning Cycle.

These three sequences are applicable to both forward and reverse operations.

4.10 As shown in Fig. 17, in order for the STU to perform a data operation on Block N + 1 from a stopped position (point E), it must first accelerate and be up to speed at point F as referenced to the read head write-type operation. For the case where the STU has just completed, a data operation on Block N and a repositioning cycle is required, the STU begins the repositioning cycle at point B and tranverses path BCDE. The STU then positions itself at point E in anticipation of the next operation. The STU presumes the next operation to be a streaming mode operation on Block N + 1. A sequence chart is presented in Table C which identifies STU streaming mode motion sequences for combinations of previous and present command issuances. In all cases, the next command is already in the buffer so that it meets the reinstruct time.

4.11 ***Command in Buffer During Reinstruction Internal:*** In the streaming mode, if the transport receives a command during the resinstruction interval (Fig. 18), the velocity of the tape motion will be maintained without interruption through the processing of block N and N + 1.

4.12 ***Command Received During Repositioning Cycle:*** In the streaming mode, if the transport receives a command during the reposition

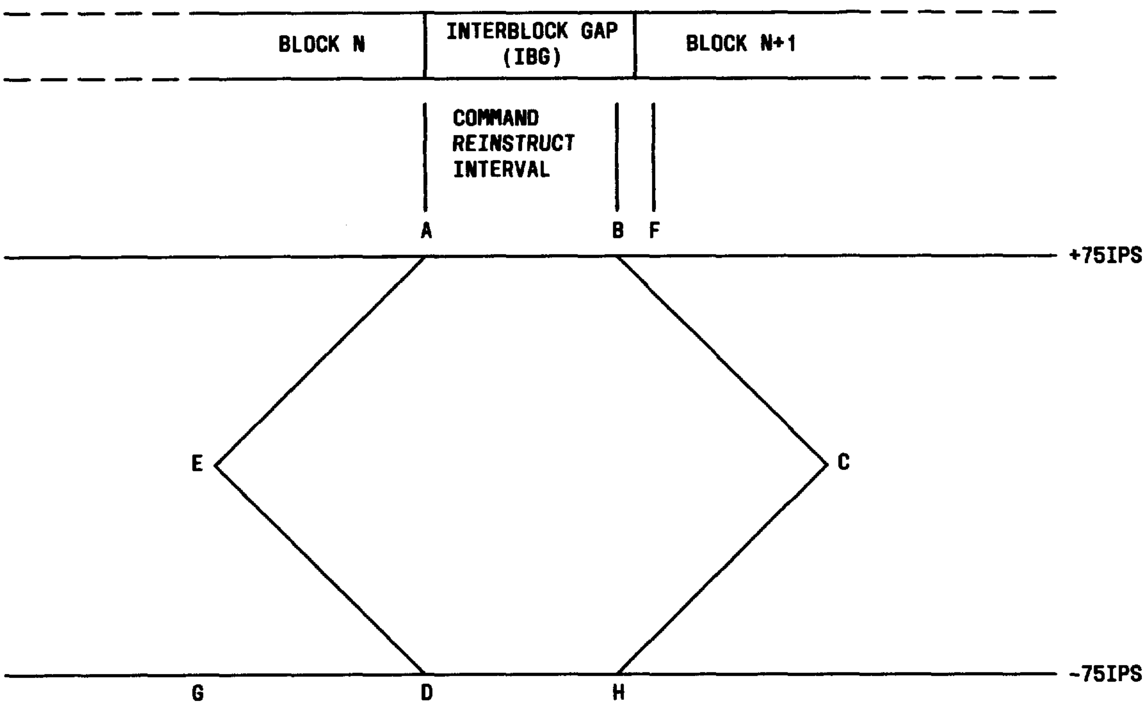


Fig. 17—Streaming Mode Velocity Diagram

TABLE C

STREAMING MODE MOTION SEQUENCE CHART

PREVIOUS COMMAND	NEXT COMMAND		
	FORWARD READ-TYPE	REVERSE READ-TYPE	WRITE-TYPE
Forward Read-Type	Path ABF	Paths ABC, CHDG	Path ABCDEF
Reverse Read-Type	Paths HDE, EABF	Path HDG	Paths HED, EABF
Write-Type	Not Recommended	Paths ABC, CHDG	Path ABF

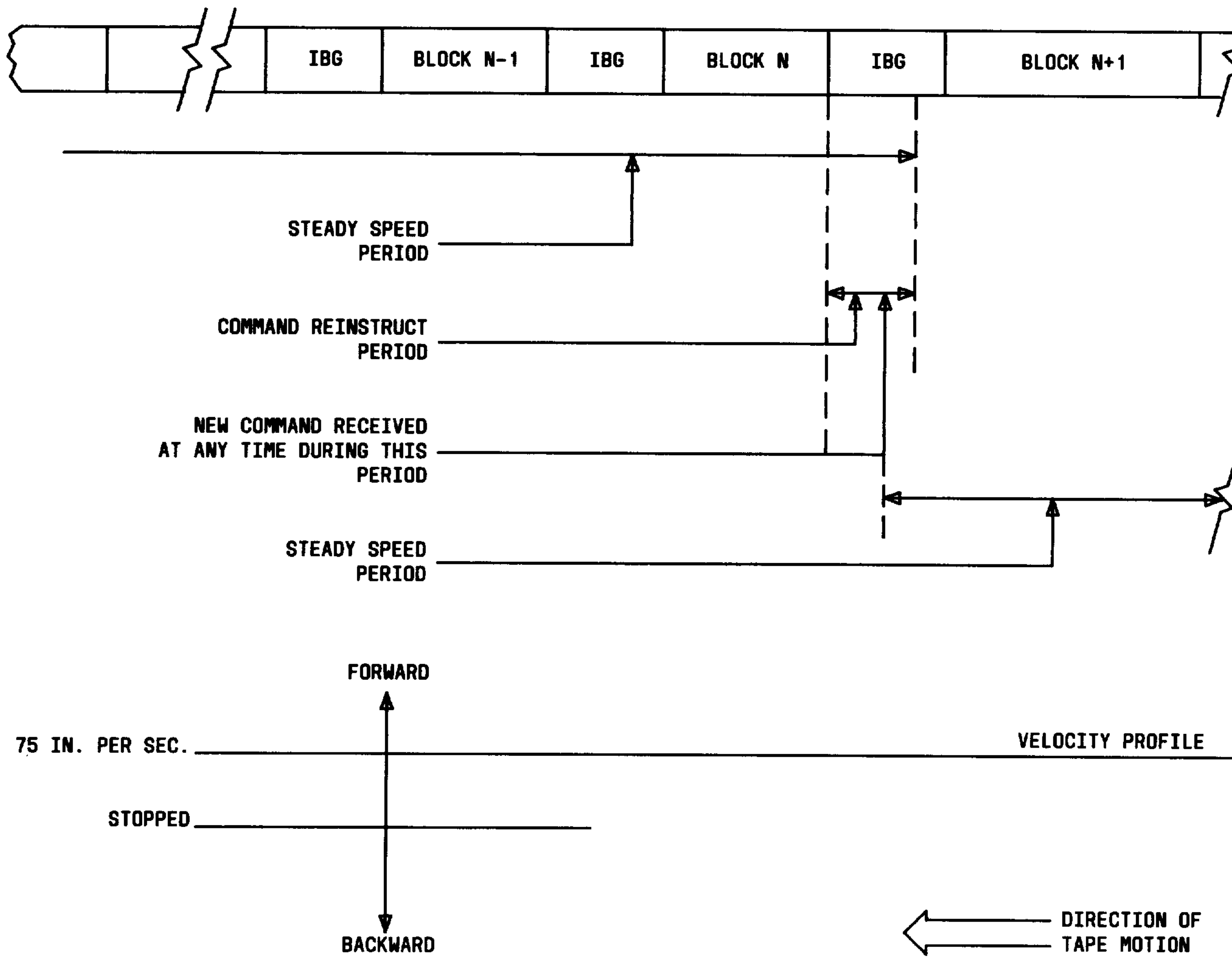


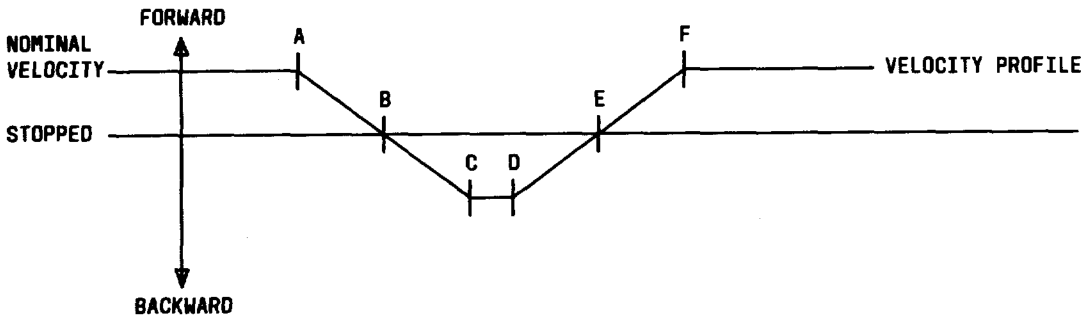
Fig. 18—Tape Motion Control (Nonstop)

cycle, the tape will momentarily stop and change the direction (Fig. 19). The velocity profile identifies the time sequence of events. The correspondence between the time and distance is shown in Fig. 20.

4.13 In the streaming mode, if the transport receives a command following the repositioning cycle, the tape motion will stop and wait for the new command (refer to Fig. 21 at point E1 to E2). The tape motion will start at point E2 if the transport receives a new command. The correspondence between time and distance is shown in Fig. 22.

4.14 Tape motion continues without loss of time due to starting and stopping if the next command is received during the command reinstruction time. The tape unit maintains 75 IPS speed through the interblock gap, anticipating the next command. If the transport receives a command within the reinstruction time, there is no loss of time due to starting and stopping. If commands arrive after reinstruction time or if the commands are discontinued, the transport will go through a recovery cycle. All read/write commands can be executed in this mode except read reverse, which is not an accepted command in the streaming mode.

4.15 ***Low-Speed (25 IPS) Mode Control:*** The tape unit will automatically switch between 25-IPS streaming mode and 25-IPS start/stop mode in response to the system usage. Essentially, when repositioning becomes excessive in the streaming



EVENT	VELOCITY PROFILE POSITION
STEADY SPEED PERIOD	UP TO POINT A
FORWARD MOTION DECELERATION	A-B
TAPE MOTION STOPPED MOMENTARILY	B
REVERSE MOTION ACCELERATION	B-C
FULL SPEED REVERSE MOTION	C-D
REVERSE MOTION DECELERATION	D-E
TAPE MOTION STOPPED MOMENTARILY	E
FORWARD MOTION ACCELERATION	E-F
STEADY SPEED FORWARD THROUGH DATA BLOCK N + 1	POINT F AND ON

Fig. 19—Streaming Mode Velocity Diagram (Momentary Stop)

mode, rather than continue to "thrash," the transport will switch to start/stop mode. The benefits of this change are significant. If the system cannot reinstruct to keep the unit in streaming mode, a 221-millisecond reposition cycle is required before processing of the next block of data can occur. In start/stop mode, the access time is reduced to 64 milliseconds in the worst case (if previous block of data is one byte) or to 24 milliseconds (if previous block of data is greater than 1.6 kilobytes). The transport will switch back to streaming mode when the command reinstruction time consistently reduces to a value that will allow the streaming mode. The following items are very important for this category:

(a) To avoid "jog" delays, mode switching is performed at a speed of 25 IPS, rather than in stationary. In essence, a mode switch takes effect at the end of the block in the process.

(b) If the time to traverse the preceding block, plus the reinstruction time, exceeds 60 milliseconds, the access time will be 22 milliseconds for a write operation and 24 milliseconds for a read operation. The access time will be increased by the difference between 60 milliseconds and the time to traverse the preceding block, plus the reinstruction time, if the previous criterion is not met.

COMMANDS

4.16 The selected tape transport will respond to the following peripheral commands only after the "GO" pulse is initiated.

(a) ***Forward/Reverse:*** A logical true selects reverse operation. A logical false selects forward operation. A logical true means a TTL signal "low" exists on the bus lead between the peripheral controller and the tape drive, and the logical false means a TTL signal is "high".

(b) ***Read/Write:*** A logical true (in the write mode) writes a file mark on the tape.

(c) ***WFM (Write File Mark):*** A logical true (in the write mode) writes a file mark on the tape.

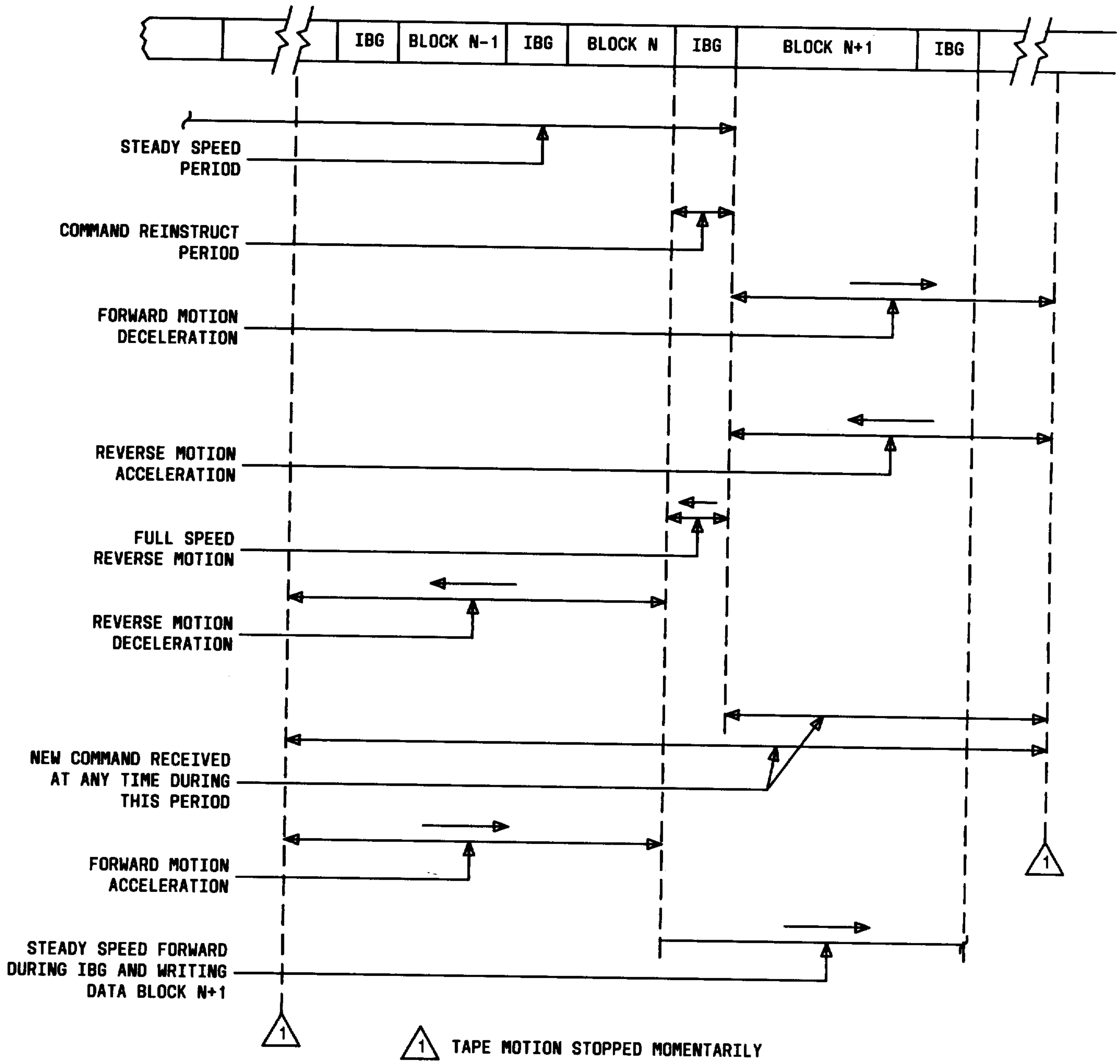
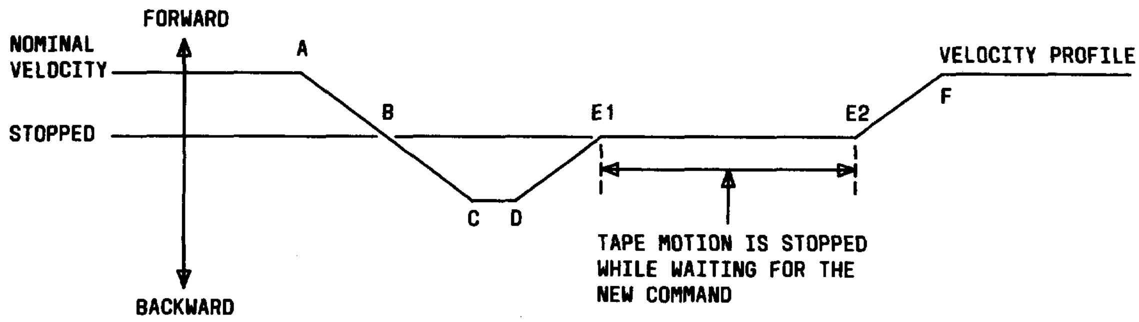


Fig. 20—Streaming Mode Tape Motion Control (Momentary Stop)



EVENT	VELOCITY PROFILE POSITION
STEADY SPEED PERIOD	UP TO POINT A
FORWARD MOTION DECELERATION	A-B
TAPE MOTION STOPPED MOMENTARILY	B
REVERSE MOTION ACCELERATION	B-C
FULL SPEED REVERSE MOTION	C-D
REVERSE MOTION DECELERATION	D-E1
TAPE MOTION STOPPED WHILE AWAITING NEW COMMAND	E1-E2
FORWARD MOTION ACCELERATION	E2-F
STEADY SPEED FORWARD THROUGH DATA BLOCK N + 1	POINT F AND ON

Fig. 21—Transport Velocity Diagram (Receiving Command Following Repositioning Cycle)

(d) ***Last Word:*** A logical true indicates to the formatter that the present data character, which is placed on the input data lines, is the last character of the record.

(e) ***Formatter Enable:*** A logical false causes initialization of the formatter.

(f) ***Sense:*** A logical true allows the looping back of data transfers to the formatter for diagnostic of the bus.

4.17 The "rewind" command is a pulse that does not require the "GO" pulse to initiate. The rewind pulse causes the selected on-line transport to rewind the tape to the load point. This pulse will not cause a formatter busy signal to go to a logical true.

A. Formatter Response

4.18 The formatter provides the following status indications to the controller.

(a) ***Formatter Busy:*** This is a logical true that follows the trailing edge of the "GO" pulse when the peripheral controller issues the command and inhibits further commands to the formatter.

(b) ***Data Busy:*** The data busy signal is logical true when the tape is up to speed, when the transport traverses the interblock gap, and when the formatter is about to write or read data to or from the tape. The data busy signal remains true until the data transfer and the post-record delay are completed.

(c) ***File Mark:*** This is a pulse that is generated when a completed file record has been detected on the tape during a read or write operation.

(d) ***Write Strobe:*** This pulse indicates that the write data lines are transferring an 8-bit data character and parity from the peripheral controller to the formatter.

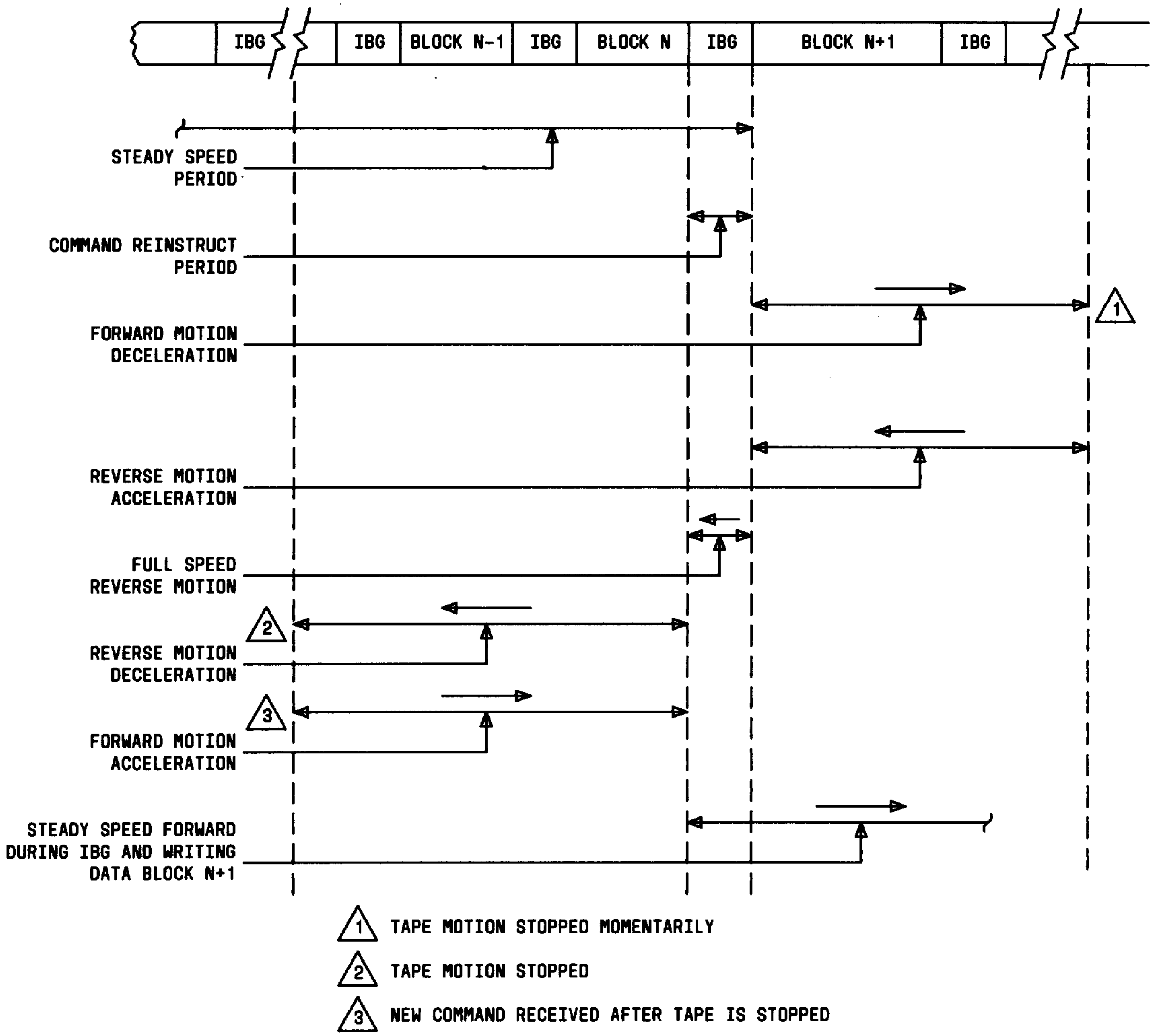


Fig. 22—Tape Motion Control (Receiving Command Following Repositioning Cycle)

(e) ***Read Strobe:*** This pulse indicates that the formatter reads an 8-bit data character and parity from the tape and puts it on the read data lines.

4.19 The following responses indicate status and configuration of the tape transport.

(a) ***Ready:*** This logical true level indicates that the tape is tensioned; is not rewinding, off-line, or loading; and is ready to receive a write command.

(b) ***On Line:*** If this level is logical true, it indicates that the tape transport is under remote control. If it is logical false, the transport is under local conrol.

(c) ***Rewinding:*** This true level indicates that the transport is in rewind operation or returning to the load point.

(d) ***File Protect:*** This logical true level indicates that the takeup reel has no write permit ring and that the write electronics are disabled.

(e) ***Load Point:*** When the load point reflective marker is under the photosensor and the transport is not rewinding, the load point signal will go to a logical true state.

(f) ***EOT(End of Tape):*** The EOT signal changes to a logical true state when the EOT marker is detected in the forward direction. The EOT signal remains true until the transport receives a rewind command.

B. Error Detection

4.20 The formatter provides the following types of error detection responses:

- Corrected error
- Hard error.

4.21 The corrected error indicates that a single track error has been detected during a read operation and that corrected data is being sent. The hard error indicates that an uncorrectable error has occurred and that the record should be reread or rewritten.

ADAPTIVE VELOCITY CONTROL

4.22 Rather than selecting 25 IPS mode when low speed is commanded, the STU will enter a mode in which the most optimum speed will be chosen to match system requirements. If 75 IPS gives the best throughput, then this mode will be used; the same applies to 25 IPS streaming and 25 IPS start/stop. This choice of operating mode is done automatically by the STU and does not require any involvement by the host system. This feature allows the STU to be interfaced to a standard adapter and to run under standard 1/2 inch tape software and yet offer the advantage of streaming.

4.23 With this feature enabled, the tape unit will respond to a set 75-IPS command in the normal manner.

Note: This feature may be disabled by relocating a pluggable jumper on one of the printed circuit boards.

5. STU/ADAPTER INTERFACE

5.01 The STU interface is based on the Industry Standard Interface for 1/2 inch tape products. Modifications to this standard interface are required to accommodate the STU. Additonal capability is provided as follows:

(a) Speed Mode Operations — High speed select and status lines required for setting high or low speeds and identifying motion states when in nonbuffered mode. An additional feature is provided through a jumper such that the STU can automatically adjust its speed to provide data throughput consistent with prevailing host system operating conditions.

(b) Gap Length Controls — Establish normal or long IBG (Interblock Gap). The long and short gaps are fixed or variable. The STU is shipped with long and short gaps selected in the variable modes. Jumpers on the formatter write PWA allow for the control of gap lengths. Gap control is selectable in unbuffered mode only.

(c) Sense Transfer — Allows for the transfer of STU sense information. Two sense commands are supported. The Read Sense command transmits 8 sense bytes to the host. These 8 sense bytes are valid in both PE and GCR modes. A Read Extended Sense command is also supported. This command transmits 32 sense bytes to the host. The Read Extended Sense command has meaning in both PE and GCR modes.

(d) STU Interface Loopback — Allows for the looping of write to read lines on the STU interface. This command is valid in both PE and GCR modes.

(e) Programmable Clip or Threshold — Can be used for error recovery during read operations only. The threshold selection can be used for both PE and GCR in unbuffered mode only. The clip level line (RTHR) is strobed with the GO pulse with the Read command. RTHR = 1 is high command.

(f) Switchable Options — Jumpers/switches on the STU I/O board have as selections:

Jumpers/Switches	State In Which Shipped
• Data Transfer Rate	375K
• Maximum Record Size	8K
• Density Select	Local (selected by operator)
• Auto Error Recovery	Enabled
• Write Parity	Enabled
• Adaptive Velocity Control	Enabled
• Density Status	Enabled
• Start Data Delay	5ms

(g) Remotely Initiated Diagnostics — The Run Remote Diagnostics command is followed by two data bytes on the write data lines. These bytes contain the test number and test options, respectively.

Operating Mode

5.02 The STU is interfaced to the host system by a fully buffered interface board. This fully buffered approach allows the streaming transport to emulate a high speed start/stop tape drive.

> *Note:* All data error recovery is performed by the STU without assistance from the host system. No data errors will be reported unless error recovery is unsuccessful (unrecoverable read or write error encountered) while the switchable option is enabled.

System Configuration

5.03 The minimum system configuration provides for a single tape unit. Terminations for the TTL logic are installed on the interface board. The maximum cable length is 20 feet.

5.04 The maximum system configuration consists of four tape units daisy-chained together. Only the last tape unit will have terminators installed in the interface board and intermediate tape units should have their factory-installed terminators removed. The maximum cable length is 20 feet.

6. COMMAND CLASSIFICATION

6.01 The transport command set is placed into five categories dealing with the type of command being executed. These commands are as follows:

(1) Motion control (rewind and speed mode change)

(2) Mode control (on-line, off-line/rewind, density select, and long gap select)

(3) Data operation (read or write)

(4) Read sense (sense data transfer and extended sense data transfer)

(5) Diagnostic (write-to-read data channel loopback and run remote diagnostics).

COMMAND SET

6.02 The motion and mode control commands are associated with the peripheral controller. The peripheral controller sends these commands over the interface bus to the tape transport. The data operation, read sense, and data loopback commands are associated with the formatter. The formatter transfers these comands via the FGO strobe sampling of the interface lines.

Write Command

6.03 The Write command causes the STU to start transferring data. The data transfer continues until the Last Word command is given from the host controller.

6.04 In the buffered mode, Write commands will be stacked and processed as follows: The first Write command will initiate a data transfer operation between the host and data buffer. Data Busy will be activated and Demand Write Data Strobes will be generated at the channel rate, as defined by the channel rate jumpers, as data is transferred to the buffer. When the buffer reaches a predetermined level (calculated on operating speeds, density, and ramp time), the interface board will issue the Write command to the formatter, which will then start tape motion. In the meantime, data may still be transferring from the host to the buffer. When the tape is up to speed, the formatter will start transferring data out of the buffer to the tape. When Last Word is received from the host, Data Busy will be deactivated and the interface board will be ready to accept another command. The interface board will continue to transfer data from the data buffer to the formatter until Last Word is reached. If another Write command has been received, the sequence will continue.

6.05 As long as the host continues to send Write commands, and the channel transfer rate is higher than the tape transfer rate, streaming will be maintained and the buffer will eventually fill up. The buffer is not considered full if there is enough space for a record of the size as defined by the maximum-record-size jumpers. If the host attempts to write a larger record than this, when there is only one record space available, the interface board will stop transferring data, but will continue sending demand write data strobes until Last Word is received. The HER (hard error) line will then be set to indicate that the record was not successful. An early warning will be generated by the servo control to indicate when the end of the tape is approaching. This will cause the interface board to start degrading the buffer operation so that it will not contain more than 5 feet of data when the physical EOT is detected from the drive.

6.06 If a data error is detected while writing, the interface board will issue a Backspace and Fixed Erase per the error recovery procedure. The record will than be rewritten and the write error counter will be incremented. (The error counters will be available to the host in sense bytes.) If a command other than the Write is received, the interface board will continue to issue Write commands to the drive until the buffer is empty. The interface board will then initiate the command which is pending. In the event that an error occurs that cannot be correct, FHER line will be set. The number of records still in the buffer will be available in the sense. This count includes the one where the error occurred.

Write File Mark Command

6.07 The Write File Mark command causes the STU to write the proper file mark pattern on the tape in its correct position relative to the write data in the buffer.

Erase Commands

6.08 Erase commands are only executed if no data is present in the interface buffer. The following Erase commands are used:

- Fixed Erase — This command causes 3 inches of tape to be erased. The ID burst will be written when an Erase command is given from BOT.
- Controlled Erase — This command causes the STU to accelerate the tape and erase tape continuously until the "Last Word" signal from the controller is set true. This terminates the erase operation. The ID burst will be written when an Erase command is given from BOT.
- Data Security Erase—This command causes the STU to erase tape at 75 IPS from its present position to a position approximately 10 feet past the End of Tape marker. The ID Burst will be written when the command is given from BOT.

Real Forward Command

6.09 The Read Forward command will cause the interface board to initiate a read operation on the drive and the data will be transferred to the buffer. Data will not be transferred to the host until the complete record is in the buffer with no errors. If an error is detected, the interface board will issue a backspace to the drive, re-read the record, and update the read error counter. Retrys will be performed as described in the retry procedures. If there are no errors, Data Busy will be activated to the host and read strobes will be generated at the host channel rate until the complete record has been transferred from the buffer to the host.

6.10 In the meantime, anticipating that other Read commands will be issued and to maintain streaming, the interface board will initiate another Read command to the drive and start transferring the data to the buffer. This will continue until the buffer is full or until a command other than Read is received from the host. In the event that a file mark is detected or a different type command is received, and there are more records in the buffer than were requested, the interface board will cause the tape to be backspaced to the end of the last record that was successfully transferred to the host. The command that is pending will then be performed.

6.11 In the event of an uncorrectable data error in the buffered mode, and if auto-error recovery is enabled, the buffer will initiate a Backspace and then re-read the record.

Read Reverse Command

6.12 In the PE mode, the operation of the Read Reverse command is similar to the Read Forward command, but with tape motion in the reverse direction.

6.13 in the GCR mode with the buffer enabled, the Read Reverse command will be executed as a Space Reverse command followed by a Read Forward command. The data will be reversed before being transferred to the host system.

6.14 The Reverse Read command in the GCR and nonbuffered mode is not supported. The STU will perform a backspace and return HER on completion.

Space Forward Command

6.15 The Space Forward command operation is similar to a Read Forward command except that no read stroke signals are generated and no read data is supplied to the controller. Error checking is not performed on the read data. however, file mark testing is performed.

Space Reverse Command

6.16 The Space Reverse command operation is similar to the Space Forward command operation except the STU moves the tape in the reverse direction.

File Mark Search Commands

6.17 These commands cause the STU to continuously read forward or read reverse in "on-the-fly" mode. Tape motion ceases when a file mark is read with the head correctly positioned. When combined with the Erase commands, data transfer and error detection is inhibited.

Rewind Command

6.18 This command causes the STU to rewind to BOT. The Rewind command is ignored if the unit is already at BOT.

Off-Line Command

6.19 The Off-Line command causes the STU to perform the Off-Line, Rewind, and Unload tape operations.

On-Line Command

6.20 The On-Line command causes the STU to go on-line if the tape is loaded.

Off-Line Command

6.21 This command causes the STU to go off-line, rewind.

Channel Loopback Command

6.22 The Channel Loopback command is a diagnostic command used to loopback the STU Interface write data lines to read data lines. The STU generates Demand Write Data Strobes and loops back the write data from the STU Interface to the read data lines until the Last Word signal is received. Formatter Busy and Data Busy are reset when the last data byte is transmitted. Data transfer rate is at the present channel speed.

Sense Read Command

6.23 This command transfers STU sense information to the controller. The sense transfer is similar to a read operation of a fixed length record except that no tape motion is involved. The transfer rate of the data will be the same as that which is currently in force. The STU generates a read strobe for every sense byte transferred. Eight bytes of sense information are transferred during the Read Sense command. Thirty-two sense bytes are transferred during the Read Extended Sense command. The STU does not have to be on-line to execute a Sense Read command.

Run Remote Diagnostics Command

6.24 The Run Remote Diagnostics command enables the host to execute diagnostic functions which are resident within the control storage of the subsystem. Diagnostic tests pertaining to interface, formatter, and drive hardware elements may be initiated by invoking this command, and following the command with a 2-byte data transfer which passes a test number and test option byte to the subsystem.

6.25 Successful completion of the diagnostic test is indicated by Formatter Busy dropping.

6.26 Unsuccessful completion is indicated by the FHER line set. The host should then issue a Read Sense command to obtain the fault symptom code byte. If both the Fault Code and Fault Subcode are required, the host should issue the Read Sense command.

Select PE Density Command

6.27 This command is issued by the host systems to put the tape unit in the PE mode. The dropping of the Formatter Busy indicates completion of this command. This command is only accepted when the tape is positioned at BOT. Unsuccessfull completion is indicated by the FHER line set.

Select GCR Density Command

6.28 This command is issued by the host system to put the tape unit in the GCR mode. The dropping of Formatter Busy indicates completion of the command. This command will only be accepted when the tape is positioned at BOT. The drive executes Load operations in PE mode, regardless of the density selected. A prerecorded tape will automatically be read at the density at which it was written, even if the incorrect density has been selected. If this condition occurs, the hard error status bit and the density conflict sense bit (sense byte 3, bit 2) are set. Unsuccessful completion is indicated by the FHER line set.

Set Buffer Enabled Command

6.29 This command, when issued by the host system, will cause the interface control to switch back to the buffered operation if it was in the unbuffered mode. The default at power-on will always be enabled.

Clear Buffer Enabled Command

6.30 This command, when issued by the host systems, will cause the interface control to switch from the buffered mode to the unbuffered mode for all succeeding data operations.

7. DIAGNOSTIC

7.01 A small amount of diagnostic code will reside in the read-only memory of the peripheral controller. This diagnostic code will be used for initialization and verification of basic functions when bringing up the peripheral controller diagnostic.

PERIPHERAL CONTROLLER RESIDENT BOOT DIAGNOSTIC

7.02 The central control contains the peripheral controller diagnostic. It pumps the diagnostic routine into the peripheral controller under the system command. The diagnostic routine will thoroughly test the peripheral controller and give the result as a passed or failed indication.

FORMATTER DIAGNOSTIC

7.03 The formatter contains the diagnostic routine which features the following modes of testing:

- Basic test automatically performed when power is turned on.
- Continuous monitoring of vital operation parameters during all tape operations.
- Off-line tape motion diagnostic test.

8. REFERENCE

8.01 Refer to AT&T 254-302-000 for information relevant to this section.

9. ABBREVIATIONS

9.01 The following is a list of abbreviations used in this section.

ANSI — American National Standard Institute

AOT — Absence of Tape

BOT — Beginning of Tape

BPI — Bits per Inch

CRC — Cyclic Redundancy

DMA — Direct Memory Access

ECC — Error Correction

EMC — Engineered Military Circuit

EOT — End of Tape

EPROM — Eraseable Programmable Read Only Memory

ERR — Error

GRC — Group Coded Recording

HER — Hard Error

I/O — Input/Output

IOP — Input/Output Processor

IPS — Inch Per Second

LDPM — Lower Dual Port Memory

LDFT — Load Disk From Tape

MP — Microprocessor

PE — Phase Encoded

PIA — Peripheral Interface Adapter

PIC — Peripheral Interface Controller

PSI — Pounds per Square Inch

PTM — Programmable Time Module

PROM — Programmable Read Only Memory

RAM — Random Access Memory

ROM — Read Only Memory

R/W — Read/Write

STU — Streaming Tape Unit

TTL — Transistor-Transistor Logic

UDPM — Upper Dual Port Memory